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New York State Museum

JOHN M. CLARKE, Director

Museum Bulletin 166

THE MINING AND QUARRY INDUSTRY OF NEW YORK STATE

REPORT OF OPERATIONS AND PRODUCTION DURING 1912

BY

D. H. NEWLAND

Smithsonian Institution JUL 29 1915 232635 National Museum

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THE UNIVERSITY OF THE STATE OF NEW YORK

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SIR: I beg to communicate herewith for publication as a bulletin of the State Museum, our annual report on the Mining and Quarry Industry of New York, which has been prepared by D. H. Newland, Assistant State Geologist.

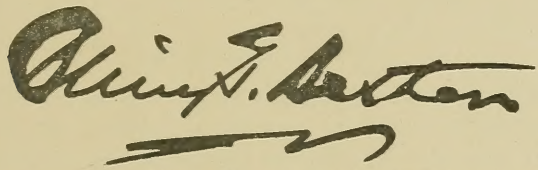
Very respectfully

JOHN M. CLARKE

Director

THE UNIVERSITY OF THE
STATE OF NEW YORK

Approved for publication this 12th day of August 1913



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Museum Bulletin 166

THE MINING AND QUARRY INDUSTRY

OF

NEW YORK STATE

REPORT OF OPERATIONS AND PRODUCTION DURING 1912

BY

D. H. NEWLAND

INTRODUCTION

The mineral resources of the State were very actively exploited in 1912 and the volume of business reported by many branches of the industry was of record proportions. In the face of the strong demand that prevailed throughout the year, prices for most products showed no marked advance; in fact they were but little above the average of the previous season, a period characterized by reaction and more or less pronounced depression. Under more favorable market conditions the yield, undoubtedly, would have reached a new figure; as it was the total fell short of the maximum by only a small amount.

A summary of the reports rendered by the mining and quarry enterprises throughout the State shows the actual value of the production to have been $36,552,784. This represented a gain of nearly 17 per cent, as compared with the amount reported for 1911, $31,730,747. The increase was more than enough to restore the

loss incurred by the decline of the latter year and placed 1912 almost on a par with the record year of 1907 when the total reached $37,142,006.

The materials on which these production figures are based number over thirty and represent in most cases the first products of the mines and quarries. They do not of course cover the whole field of enterprise in this department of activity, since there are many large industries based on their further elaboration or manufacture, as well as others of equal importance engaged in the treatment of products secured from sources outside the State. Among such industries may be mentioned the manufacture of aluminum, calcium carbide, carborundum, pig iron and steel, soda products, coke, and many others that together greatly exceed in value of their outturn those branches under present consideration.

Among the metallic minerals found in the State, iron ore is the most valuable from an industrial standpoint. The gross output of this ore last year was 1,277,677 long tons. After allowance for concentration, which is practised by the Adirondack mines, there remained a total of 1,057,702 long tons of shipping ore which had a value of $3,349,095, as compared with 952,364 long tons valued at $3,184,057 for the year 1911. There was a good advance among the mines in the Clinton belt, though the magnetite ores as usual constituted the greater part of the production. New developments have been in progress which may lead to a material advance in the industry in the near future.

The clay-working industries contributed the largest items of the totals, with an aggregate value of $11,947,497 in 1912, and $9,751,659 in the preceding year. The large gain in production during the year was due largely to a better demand for structural materials, including common and pressed building brick, terra cotta, hollow fireproofing, etc., of which the total value amounted to $8,301,839, as compared with $6,473,857 in the preceding year. The number of brick for building purposes made in 1912 was 1,205,704 thousands, against 1,078,019 thousands in 1911, about three-fourths in each year being manufactured in the Hudson River district. The pottery trade also showed an improvement and the returns indicated a total value for the production of $2,876,762 which was a new record. About 200 firms were engaged in the various clay-working branches.

The improved conditions in the building trades also brought about an increased output of quarry materials, inclusive of granite, lime-

stone, marble, sandstone and trap, which were valued in the aggregate at $5,718,994. The total for 1911 was $5,560,355. Divided according to uses the output for 1912 consisted of building stone valued at $692,534, monumental stone $103,641, curbstone and flagstone $621,327, crushed stone $2,754,839, and miscellaneous $1,546,653. More than one-half the value was returned by the limestone quarries which furnish the greater part of the crushed stone used for concrete and macadam. The marble and trap quarries were less active than usual, but there was a gain in both granite and sandstone.

In the cement trade, conditions showed a great improvement compared with their trend in recent years, which had been steadily reactionary. The demand for both portland and natural cement was brisk and prices advanced steadily with the progress of the season. The combined product of the two kinds amounted to 4,783,535 barrels, against 3,691,373 barrels in 1911. The gain was mostly recorded by the portland cement plants which contributed 4,495,842 barrels to the total, as compared with 3,416,400 barrels in the preceding year. Natural cement constituted an aggregate of 287,693 barrels, against 274,973 in 1911. Owing to the fact that the output of the mills was delivered largely under contracts, the value of the production averaged less than in 1911, though current prices were considerably higher.

Salt is a commodity that has been produced in the State for upwards of a century. It is obtained both by mining underground and by sinking wells into the salt, the brine from these being evaporated by solar or artificial heat, or used directly for chemical manufacture. The quantity of salt raised from the mines and wells in 1912 amounted to 10,502,214 barrels, and had a value at the place of production of $2,597,260, both totals exceeding those for any previous year. Livingston county, with the only active salt mines in the State, was the leading producer.

The mining of gypsum, the raw material from which plaster of paris and hard wall plasters are made, has become an important industry of late years, having had a very steady growth in the last decade. The material is mainly produced by underground operations, though in some localities it is quarried. The output for 1912 amounted to 506,274 short tons and in its marketable forms had a value of $1,186,845.

The combined value of petroleum and natural gas, the only representatives of the class of mineral fuels obtained in the State,

amounted last year to $3,220,647. There was a material gain in the production of natural gas, the well flow having been 6,564,659 M. cubic feet against 5,127,571 M. cubic feet in 1911; but the oil industry was less active and returned an output of only 782,661 barrels, as compared with 955,314 barrels. The heavy decline in the crude oil market in 1910 was responsible in large measure for the decreased output last year, as it put a check upon new drilling that is necessary to maintain a balance with the depletion of old wells.

Among the minor industries in which New York has a prominent place by reason of its natural resources, are those of talc, garnet, graphite and pyrite. Talc is mainly obtained from a single district in St Lawrence county, which has a practical monopoly of the fibrous talc trade. The production last year amounted to 61,619 short tons valued at $511,437, or about the usual quantity. Garnet for abrasive use is produced in Essex and Warren counties, and the output last year was 4112 short tons with a value of $117,325. Graphite of the more valuable crystalline sort is found in the Adirondack region; the total product last year was reported as 2,628,000 pounds and represented a value of $142,665. Pyrite for acid manufacture is mined in St Lawrence county.

The remaining mineral materials represented in the list of products for last year included apatite, clay, diatomaceous earth, emery, feldspar, marl, millstones, metallic paint, mineral waters, slate pigment, quartz, slate, sand, sand-lime brick, and zinc ore. There were no additions to the list during the year, but on the other hand one industry — that connected with the production of carbon dioxid from natural sources — was discontinued as the result of the recent action taken for the conservation of the Saratoga mineral waters.

Mineral production of New York in 1911

PRODUCT	UNIT OF MEASUREMENT	QUANTITY	VALUE
Portland cement	Barrels	3 416 400	$2 930 434
Natural-rock cement	Barrels	274 973	134 900
Building brick	Thousands	1 078 019	5 443 303
Pottery	.....	.....	2 196 054
Other clay products	.....	.....	2 083 405
Crude clay	Short tons	14 193	11 982
Emery	Short tons	769	8 810
Feldspar and quartz	Short tons	21 802	75 719
Garnet	Short tons	4 285	121 759
Graphite	Pounds	2 510 000	137 750
Gypsum	Short tons	446 794	1 092 598
Iron ore	Long tons	952 364	3 184 057
Millstones	.....	.....	13 177
Metallic paint	Short tons	7 237	68 870
Slate pigment	Short tons	1 646	12 864
Mineral waters	Gallons	8 923 628	756 147
Natural gas	1000 cubic feet	5 127 571	1 547 077
Petroleum	Barrels	955 314	1 251 461
Pyrite	Long tons	53 453	251 466
Salt	Barrels	10 082 656	2 191 485
Sand and gravel	.....	.....	1 727 367
Sand-lime brick	Thousands	15 178	92 064
Roofing slate	Squares	11 273	52 311
Slate manufactures	.....	.....	Nil
Granite	.....	.....	148 633
Limestone	.....	.....	3 174 161
Marble	.....	.....	278 041
Sandstone	.....	.....	1 060 106
Trap	.....	.....	899 414
Talc	Short tons	65 000	552 500
Other materials [1]	.....	.....	232 832
Total value	.....	.....	$31 730 747

[1] Includes apatite, carbon dioxid, diatomaceous earth, marl and zinc ore.

Mineral production of New York in 1912

PRODUCT	UNIT OF MEASUREMENT	QUANTITY	VALUE
Portland cement	Barrels	4 495 842	$3 488 931
Natural-rock cement	Barrels	287 693	142 165
Building brick	Thousands	1 205 704	6 889 940
Pottery	.....	.....	2 876 762
Other clay products	.....	.....	2 180 795
Crude clay	Short tons	8 583	18 980
Emery	Short tons	589	6 479
Feldspar and quartz	Short tons	28 584	115 419
Garnet	Short tons	4 112	117 325
Graphite	Pounds	2 628 000	142 665
Gypsum	Short tons	506 274	1 186 845
Iron ore	Long tons	1 057 702	3 349 095
Millstones	.....	.....	15 358
Metallic paint	Short tons	8 012	72 176
Slate pigment	Short tons	1 750	12 800
Mineral waters	Gallons	9 682 447	760 847
Natural gas	1000 cubic feet	6 564 659	1 882 297
Petroleum	Barrels	782 661	1 338 350
Pyrite	Long tons	58 137	286 577
Salt	Barrels	10 502 214	2 597 260
Sand and gravel	.....	.....	2 549 729
Sand-lime brick	Thousands	21 231	133 736
Roofing slate	Squares	9 738	83 222
Slate manufactures	.....	.....	Nil
Granite	.....	.....	202 096
Limestone	.....	.....	3 510 445
Marble	.....	.....	241 847
Sandstone	.....	.....	1 280 743
Trap	.....	.....	483 863
Talc	Short tons	61 619	511 437
Other materials [1]	.....	.....	74 600
Total value	.....	.....	$36 552 784

[1] Includes apatite, diatomaceous earth, marl and zinc ore.

CEMENT

The cement business last year was of large volume, but in the early months was conducted on a small margin of profit to the manufacturer. Prices showed, however, an upward trend with the progress of the season, the first really sustained improvement in the market that had taken place for some time. This lent an encouraging aspect to the year's record as compared with that of 1910 or 1911, and appeared to indicate that the critical period which tested the financial and technical equipment of the plants as never before had been passed.

The opening of the year found the companies carrying heavy stocks and prices on the same low level they reached in the latter part of the preceding season. Demand was exceptionally heavy and served to absorb most of the surplus in the next few months, so that by spring the mills were able to make a slight advance in quotations. There was no check to activity and in midsummer an additional increase was made, followed by others from time to time until by December, New York prices reached a level fully 50 per cent higher than that at the beginning of the year. The actual price movement was from about 60 cents a barrel in January to 95 cents a barrel in December, the quotations being for cement in bulk at the mill. Inasmuch as much of the selling by the manufacturers is on contract, they were, of course, not able to realize the full benefits of the advance and the average basis on which the year's sales were made may be placed at around 78 cents.

The natural cement trade in which New York State is still represented, though to a much smaller extent than formerly, followed practically the same course as indicated for the portland branch. The demand was active and at increasing prices with the season's advance. Owing to the adverse conditions experienced by manufacturers in the few preceding years, more serious in their case than in that of the portland cement companies, their plants were not in shape to allow them to take much advantage of the conditions; consequently, the outturn was not materially different from the figure reported for 1911.

In volume of production, the year was notable, the total having been exceeded but once or twice in the history of the industry. The actual quantity of portland and natural cements manufactured was 4,783,535 barrels as compared with 3,691,373 barrels in 1911 and 3,657,015 barrels in 1910. The only other years that made a comparable showing were in the period from 1895 to 1900 when the natural cement business was at the height of prosperity and contributed an output about equal to that reported last year by the portland mills.

As shown in the accompanying tables, the production of portland cement in 1912 reached the figure of 4,495,842 barrels, against 3,416,400 barrels in 1911. Its value was $3,488,931, as compared with $2,930,434 in the preceding year. The average value of the product, however, was only 77.6 cents a barrel, against 85.8 cents for 1911. There were seven mills in operation during the year, the same number as reported active in 1911.

The output of natural cement amounted to 287,693 barrels, valued at $142,165, the larger part of which was contributed by a single plant in the Rosendale district of Ulster county. The total for 1911 was 274,973 barrels with a value of $134,900. The average value was approximately 50 cents a barrel in both years. Aside from Ulster county, the only other county which was represented in the industry was Onondaga with three small plants.

Production of cement in New York

YEAR	PORTLAND CEMENT		NATURAL CEMENT	
	Barrels	Value	Barrels	Value
1892	124 000	$279 000	3 780 687	$3 074 781
1893	137 096	287 725	3 597 758	2 805 387
1894	117 275	205 231	3 446 330	1 974 463
1895	159 320	278 810	3 939 727	2 285 094
1896	260 787	443 175	4 181 918	2 423 891
1897	394 398	690 179	4 259 186	2 123 771
1898	554 358	970 126	4 157 917	2 065 658
1899	472 386	708 579	4 689 167	2 813 500
1900	465 832	582 290	3 409 085	2 045 451
1901	617 228	617 228	2 234 131	1 117 066
1902	1 156 807	1 521 553	3 577 340	2 135 036
1903	1 602 946	2 031 310	2 417 137	1 510 529
1904	1 377 302	1 245 778	1 881 630	1 207 883
1905	2 117 822	2 046 864	2 257 698	1 590 689
1906	2 423 374	2 766 488	1 691 565	1 184 211
1907	2 108 450	2 214 090	1 137 279	757 730
1908	1 988 874	1 813 622	623 588	441 136
1909	2 061 019	1 761 297	549 364	361 605
1910	3 364 255	2 939 818	292 760	147 202
1911	3 416 400	2 930 434	274 973	134 900
1912	4 495 842	3 488 931	287 693	142 165

With continued favorable conditions in the market, a further increase in the State's cement industry may be expected. The annual total should soon exceed 5,000,000 barrels, and it is certain that the local portland industry is destined to become a very prominent factor in that trade.

For the current year, the increment of an additional plant will appear in the total, as the Millen Portland Cement Co. began operations on April 1st. This company built a new mill at Jamesville, Onondaga county, a few years ago, but did not start production

until this spring. The mill has a capacity of 700 barrels a day. The materials used are limestone from the large quarries of the Solvay Process Co., nearby, and local clays.

CLAY

The clay deposits in the State are not noteworthy for their variety of character or industrial adaptability, and in fact are mainly restricted to the common sorts useful for ordinary building brick and materials of that class. They are widely distributed, however, so that practically every center of population is or may be supplied with clay structural materials from nearby yards. This branch of the industry is consequently of the greatest importance, the continued rapid expanse of population in the larger cities furnishing a market that is scarcely rivaled by that of any other state.

The clays that are utilized in brick manufacture are, with few exceptions, modified glacial deposits. Residual clays are practically absent. They have been transported from the Adirondacks and other regions of accumulation, or produced by the abrading action of the ice upon shales, and deposited in the streams and lakes that existed along the margin of the ice sheet. The most extensive beds occur in the Hudson and Champlain valleys which in late Glacial time were occupied by lakes which reached high above the present water levels. In the Hudson valley they are interstratified with sands and gravels, and build terraces on either side which lie at different elevations up to 300 feet or more. The workable clays often attain a thickness of 50 feet and in some places they exceed 100 feet. The clays have a bluish color, but are weathered to brown or yellow for some distance from the surface. They contain relatively high percentages of iron, lime and other fluxing ingredients and consequently fuse at a relatively low temperature. The color of the burned clay is generally red.

Glacial clays, more or less modified by water sorting, are also abundant in the interior and western parts, specially in the larger stream valleys. Syracuse, Rochester and Buffalo have rather extensive brick manufacturing industries which supply the local markets. Clay suitable for stoneware is found near Syracuse.

In addition to common brick, which is the principal article produced from these clays, the list of manufactures includes drain tile, hollow blocks, fireproofing and earthenware.

On Long Island and Staten Island are found local deposits of Cretaceous clays, similar to those of New Jersey. They have been utilized to some extent for stoneware and brick by Long Island manufacturers, but the principal developments have been at Kreischerville and Green Ridge, Staten Island. At Kreischerville, excellent grades of fire brick and fancy pressed brick are made from these clays.

Besides the surficial clays, the shale beds which are found in the Paleozoic strata, especially of the Devonic system, afford much material that is adapted for building and paving brick, terra cotta, tile etc. They are utilized mainly in the southern and western sections. Among the localities where they are worked are Angola and Jewettville, Erie county; Jamestown, Chautauqua county; Alfred Center, Allegany county; and Corning, Steuben county. At Catskill, on the Hudson, building and paving brick are made from Hamilton shale that is dug at Cairo.

The manufacture of porcelain and chinawares has become an important branch of the industry, having shown a quite remarkable growth during the last decade. Its importance, however, is ascribable to the local facilities for assembling the raw materials and marketing the finished products. The kaolin and ball clays for the purpose are brought in from the southern states, and some of the kaolin is imported from England. The quartz and feldspar mostly come from New England, though of these materials New York possesses considerable resources which would seem to be capable of supplying some of the local requirements.

PRODUCTION OF CLAY MATERIALS

The accompanying tables give the production of clay materials during the last two or three years, the statistics being arranged according to items of manufacture and also, so far as practicable, according to counties in which the operations were carried on. They are based on reports submitted by the individual plants.

There was some improvement in the conditions affecting the clay-working industry last year as compared with those prevailing in 1910 and 1911, most noticeable in the increased output of building brick, which represents in value about one-half the entire production. The gain may be considered as indicative of a more normal state of business, after the pronounced depression that characterized the previous season, but did not suffice to bring the

total up to a new record. It was mostly contributed by the brick manufacturers in the Hudson valley, who sell in the New York market. The average prices in that important center were considerably above those reported for 1910 and 1911.

Among the other branches of the clay-working industry, those of pottery and terra cotta also showed good increases, the production of pottery being much the largest ever reputed. The remaining products, inclusive of paving brick, fire brick, drain tile, sewer pipe and fireproofing were manufactured on a reduced scale.

The actual value of the production of clay materials of all kinds in 1912 was $11,947,497 as compared with a value of $9,751,659 in 1911 and $11,518,982 in 1910. The gain for the year was $2,195,838 or about 23 per cent. The largest value recorded for any year was in 1906 when it amounted to about $14,000,000.

Production of clay materials

MATERIAL	1910	1911	1912
Common brick	$6 563 212	$5 310 511	$6 646 436
Front brick	119 859	132 792	243 504
Vitrified paving brick	333 511	307 529	174 048
Fire brick and stove lining	464 693	413 500	380 005
Drain tile	254 679	202 292	122 571
Sewer pipe	137 731	138 258	77 644
Terra cotta	1 062 017	718 700	1 139 291
Fireproofing	256 820	229 627	230 833
Building tile	65 190	82 217	42 575
Miscellaneous	134 752	20 179	13 828
Pottery	2 136 518	2 196 054	2 876 762
Total	$11 518 982	$9 751 659	$11 947 497

The product of common building brick had a value of $6,646,436 as compared with $5,310,511 in 1911, representing an increase of $1,335,925. Front brick also showed an increase, with a total value of $243,504, against $132,792. Vitrified paving brick accounted for a value of $174,048, as against $307,529, the large decrease being due to a suspension of operations by one of the larger manufacturers. Fire brick and stove lining were valued at $380,005, as compared with $413,500 in the preceding year. The output of drain tile fell off very considerably, with a total of $122,571, against $202,292 in 1911. Similarly, that of sewer pipe

amounted to only $77,644, against $138,258 in 1911. The production of terra cotta was valued at $1,139,291, as compared with $718,700; of fireproofing at $230,833, against $229,627; and of building tile, inclusive of roofing and floor tile, at $42,575, against $82,217. The miscellaneous clay manufactures, including such items as flue lining, fire tile and shapes, conduit pipes and acid-proof brick, amounted to $13,828, against $20,179 in 1911. The potteries of the State reported an output valued at $2,876,762, against $2,196,054 in the preceding year.

Of the 38 counties in the State that had representation in the clay-working industry last year, Onondaga stood at the head in the value of its product which reached a total of $1,368,345. In 1911 it also held the same place with a value of $912,892. The greater part of the product consisted of pottery which is an important industry in Syracuse and vicinity. Ulster county ranked second in the list and contributed a total of $1,296,779, all reported by the brick yards in the Hudson River section. Rockland county displaced Erie county which held third place in the previous years by reporting a value of $994,967, also represented by common building brick. Erie county with a diversified industry that includes most of the common clay manufactures besides pottery ranked fourth with products valued at $810,516. The other counties that reported a value exceeding $500,000 were Dutchess ($665,082) Orange ($615,155) Kings ($574,805) and Schenectady ($539,928).

Production of clay materials by counties

COUNTY	1910	1911	1912
Albany	$641 227	$470 503	$457 694
Allegany	*a*	9 000	*a*
Cattaraugus	63 887	90 153	135 480
Cayuga	20 675	15 724	3 740
Chautauqua	129 331	166 322	113 315
Chemung	*a*	76 169	79 510
Columbia	454 550	284 475	381 888
Dutchess	649 862	648 151	665 082
Erie	841 726	755 602	810 516
Greene	266 452	139 578	202 306
Jefferson	7 997	*a*	3 630
Kings	569 720	602 756	574 805
Livingston	*a*	70 295	125 642
Monroe	264 421	325 849	246 264
Montgomery	*a*	*a*	14 400
Nassau	111 650	105 740	119 708
New York	*a*	*a*	56 884
Niagara	22 882	25 426	22 357
Oneida	126 907	95 605	85 975
Onondaga	833 892	912 892	1 368 345
Ontario	269 549	255 298	341 617
Orange	761 500	565 152	615 155
Queens	551 375	402 398	613 605
Rensselaer	348 172	173 564	169 179
Richmond	633 010	470 591	723 875
Rockland	1 080 117	747 040	994 967
Saratoga	388 428	393 490	516 632
Schenectady	505 966	486 327	539 928
Steuben	219 615	149 649	181 663
Suffolk	101 560	73 750	92 150
Ulster	1 121 460	829 035	1 296 779
Warren	*a*	*a*	17 875
Washington	3 685	10 350	19 620
Westchester	371 328	297 997	344 798
Other counties *b*	158 038	102 778	12 113
Total	$11 518 982	$9 751 659	$11 947 497

a Included under other counties.
b In 1910, aside from counties marked (*a*), are included Genesee, St Lawrence, Tioga, Tompkins and Wayne counties. In 1911, aside from counties marked (*a*), are included Clinton, Genesee, St Lawrence, Tompkins and Wayne counties. In 1912, aside from counties marked (*a*), are included Clinton, St Lawrence, Tompkins and Wayne counties.

MANUFACTURE OF BUILDING BRICK

The manufacture of building brick is the most important branch of the clay-working industry, with regard both to the number of plants represented and the value of the product. Altogether there were 152 yards that reported as active last year, distributed among 31 counties. The total number of common brick made was

1,187,973,000. This represented an increase over the number manufactured in the preceding year, which totaled 1,066,982,000. The gain came from the counties along the Hudson river, from Rensselaer county southward, and was due to the improvement in the building trades in New York and other large cities in the vicinity. The New England trade also showed a better demand, as instanced by the increase in the production of the plants which shipped mainly to that market, notably those of Saratoga county.

The value of the common brick made last year was $6,646,436, or an average of $5.59 a thousand, as compared with $5,310,511, an average of $4.98 a thousand in 1911. The rise in prices indicated by this comparison was very substantial and the season on the whole may be considered as quite prosperous in this branch of the industry. Since 1910 the selling value at the yards has increased nearly 20 per cent.

In addition to the common building brick, there were manufactured last year 17,731,000 front or fancy brick with a value of $243,504. The output for 1911 numbered 11,037,000 valued at $132,792. The aggregate production of brick for building purposes was thus 1,205,704,000 valued at $6,889,940.

A feature of the record that appears on comparison of the statistics for several years past is the marked falling off in the number of plants and the tendency toward the restriction of the active industry to those localities or districts which possess natural advantages for manufacturing or marketing the product. As the annual output has been maintained at a fairly even rate, aside from fluctuations due to market influences, this indicates that the average outturn has enlarged very considerably, no doubt with resulting economies. In 1906, for instance, there were 231 yards in operation, distributed among 37 counties.

Production of common building brick

COUNTY	1911		1912	
	Number	Value	Number	Value
Albany	59 517 000	$319 503	69 100 000	$381 694
Cattaraugus	1 088 000	8 109	570 000	4 510
Cayuga	1 813 000	11 724	.....	.....
Chautauqua	4 140 000	28 406	3 040 000	20 483
Chemung	.....	.....	12 300 000	79 510
Columbia	57 695 000	284 475	69 434 000	381 888
Dutchess	133 229 000	648 151	122 085 000	665 082
Erie	35 975 000	222 673	43 184 000	277 696
Greene	28 779 000	139 578	36 573 000	199 360
Livingston	425 000	2 550	.....	.....
Monroe	21 100 000	116 600	22 632 000	147 107
Montgomery	.....	.....	3 200 000	14 400
Nassau	15 790 000	98 445	15 399 000	105 048
Niagara	3 178 000	25 426	3 114 000	22 357
Oneida	14 434 000	93 105	12 525 000	79 575
Onondaga	22 000 000	132 750	16 985 000	119 134
Ontario	.....	.....	2 500 000	16 250
Orange	121 800 000	565 152	113 363 000	615 155
Rensselaer	13 352 000	67 760	13 800 000	76 452
Richmond	23 456 000	106 823	33 297 000	175 358
Rockland	162 400 000	747 040	184 595 000	994 967
Saratoga	81 575 000	392 427	103 210 000	516 632
St Lawrence	.....	.....	1 988 000	13 922
Suffolk	11 500 000	68 750	15 200 000	92 150
Ulster	178 287 000	829 035	231 550 000	1 296 779
Warren	.....	.....	3 575 000	17 875
Westchester	52 654 000	263 498	52 844 000	318 422
Other counties *a*	22 795 000	138 531	1 910 000	14 630
Total	1 066 982 000	$5 310 511	1 187 973 000	$6 646 436

a Includes in 1911 Chemung, Clinton, Montgomery, Ontario, St Lawrence, Tompkins, Warren and Washington counties. Includes in 1912 Cayuga, Clinton, Jefferson, Livingston, St Lawrence Tompkins and Washington counties.

Output of common brick in the Hudson River region in 1911

COUNTY	NUMBER OF PLANTS	OUTPUT	VALUE	AVERAGE PRICE PER M
Albany	10	59 517 000	$319 503	$5 37
Columbia	6	57 695 000	284 475	4 93
Dutchess	15	133 229 000	648 151	4 85
Greene	5	28 779 000	139 578	4 85
Orange	6	121 800 000	565 152	4 64
Rensselaer	4	13 352 000	67 760	5 08
Rockland	24	162 400 000	747 040	4 60
Ulster	20	178 287 000	829 035	4 65
Westchester	6	52 654 000	256 449	4 87
Total	96	807 713 000	$3 857 143	$4 78

Output of common brick in the Hudson River region in 1912

COUNTY	NUMBER OF PLANTS	OUTPUT	VALUE	AVERAGE PRICE PER M
Albany	12	69 100 000	$414 600	$6 00
Columbia	5	69 434 000	381 888	5 50
Dutchess	17	122 085 000	665 082	5 45
Greene	6	36 573 000	199 360	5 45
Orange	8	113 363 000	615 155	5 43
Rensselaer	4	13 800 000	82 800	6 00
Rockland	23	191 595 000	1 063 352	5 55
Ulster	21	231 550 000	1 296 779	5 60
Westchester	6	52 844 000	318 422	6 03
Total	102	900 344 000	$5 037 438	$5 60

Hudson River region. Brick manufacture is carried on in the tidewater section of the Hudson river under a uniformity of conditions and on a scale that is unique in this country, if not in the world. The region embraces the nine counties along both sides of the river from Rensselaer and Albany to Manhattan island, to which may be added the proximate portion of New Jersey embraced in Bergen county. The same kind of clay is used throughout with similar methods of treatment, and the product is practically all of one grade which is classed in the market as "Hudson common hard."

In the nine counties within New York State are included about 125 yards with a capacity of one and one-quarter billion brick in the six or seven months that constitute the average season. So large an output is seldom warranted by the market requirements, however, and the average outturn may be placed at about one billion. The maximum number reported in any recent year was 1,230,000,000 in 1906.

The principal market for the product, of course, is New York and its environs, though some are shipped to the New England towns. Practically the whole output goes by water, on barges which hold upward of 200,000 each and which are made up into a fleet towed by one or more tug boats. In the lower stretch of the river, the shipments from the yards continue throughout the year, whereas the more remote ones have to concentrate their shipments during the months of open water. Formerly the product was handled by several commission agents operating independently and in competition, but in 1911, a general selling agency was established under the title of the Greater New York Brick Company, which now disposes of the output of all but a few yards. The total costs of shipment, storage in New York and commission for sales may be placed at about $1.25 a thousand.

The season of 1912 may be considered a fairly prosperous one with respect to the number of brick marketed and prices, comparing favorably in the latter particular with the preceding year or two. The output was larger than in 1911, but fell considerably below that of 1910 when under the effects of a period of overextended activity, the production far exceeded the market requirements. The surplus of that year amounted to fully 350,000,000 which were carried over into 1911, and which justified a policy of curtailment on the part of manufacturers so as to maintain a closer balance with the market. By thus restricting the outturn, manufacturers were able to maintain prices during 1911 and even to receive somewhat higher returns than the average for the previous year. The opening of the 1912 brickmaking season ranged from the middle to the latter part of May and was delayed about two weeks beyond the average date on account of wet weather. There were about 100,000,000 old brick on hand at that time. Prices started at around $6.50 a thousand, New York basis, or say $5.25 at the yard. They gradually advanced with the progress of the season and reached $7.25 in December. The open weather in the early winter enabled manufacturers to continue shipments much longer than usual, so that the stock in New York was unusually heavy at the first of the year.

The total number of brick in stock at the yards and in New York on January 1, 1913, is placed according to authoritative information at 312,004,000. The stock on May 1st was 141,204,000. These figures, of course, refer to the stocks which are held for sale in the New York market. A few plants in the more northerly counties sell a part or the whole of their output locally, as those in the vicinity of Albany and Troy, or ship by rail to the interior of the State or to New England.

The total number of brick made in the nine counties along the river last year was 900,344,000. In all, there were 102 yards active. The output at the average selling prices of the year was valued at $5,037,438, or $5.60 a thousand. The total number for 1911 was 807,713,000 valued at $3,857,143 or $4.78 a thousand. The gain in price during the past two years is well shown by comparison with the figures for 1910 when the output was larger than last year's by 200,000,000 but actually fell a little short of the given total value.

Of the several counties, Ulster leads in quantity and value of its product, with a total last year of 231,550,000 valued at $1,296,779. Rockland holds second place, contributing 191,595,000 valued at $1,063,352. Dutchess and Orange counties come next in order with nearly the same output.

OTHER CLAY MATERIALS

The manufacture of vitrified paving brick was carried on by four companies in Cattaraugus, Chautauqua, Erie and Steuben counties, the same number as in 1911. The number of paving brick made was 11,031,000 valued at $174,048, against 18,996,000 valued at $307,529 in the preceding year. The reduced output was caused largely by a shut-down of the plant at Catskill for most of the year, the plant having been taken over by a new company known as the Tidewater Brick Co. The average price of paving brick was $15.78 a thousand, against $16.19 a thousand in 1911.

Fire brick and stove lining were made in Erie, Kings, Rensselaer, Richmond, Washington and Westchester counties and their combined value was $380,005 against $413,500 in 1911. The number of fire brick made was 9,011,000 valued at $327,412. The stove lining was valued at $52,593. There were nine companies in operation, the same number as in the preceding year. Most of the clay employed in the manufacture of the materials comes from outside the State, though the product of Richmond county is made from local clays.

The output of drain tile was contributed by nine counties, of which Albany had the largest product. The value of the year's manufacture amounted to $122,571 against $202,292 in 1911. Reports were received from 16 active plants, or the same number as reported in the previous year. The value of the sewer pipe produced was $77,644 as compared with $138,258, all from Monroe county.

Fireproofing, including terra cotta lumber, hollow brick and various other kinds of hollow clay ware used for fireproofing, was made last year by six companies with plants situated among the counties of Erie, Kings, Monroe, New York, Oneida and Rensselaer. The total value of the output was $230,833, as compared with $229,627 in 1911 when 7 companies were active. Local clays are employed for these articles.

Building tile, including roofing tile, vitrified floor tile, and terra cotta tile, was reported from Allegany, Kings and Monroe counties by 3 firms. The output had a value of $42,575, against $82,217 in 1911.

Architectural or ornamental terra cotta showed a large increase last year, reaching a value of $1,139,291, as compared with $718,700 in 1911, the largest that has ever been reported. Its manufacture is carried on by 3 companies in Queens, Richmond and Steuben counties.

The miscellaneous clay materials accounted for a value of $13,828, against $20,179 in the preceding year.

POTTERY

The manufacture of pottery has become one of the larger branches of the clay-working industry, showing a steady gain of output during the last several years until it now ranks second only to brick-making in importance. The materials used are mostly brought from outside sources as there are no deposits of white-burning clays suitable for china or porcelain within the State. Feldspar, quartz and stoneware clays, as well as an excellent grade of slip clay, exist in large deposits, but except for slip clay, the local resources are not utilized to any extent for pottery. The recent growth of the home market seems to afford opportunity for development of some of those resources, especially those of feldspar and quartz.

The products of New York potteries include porcelain and china tableware which are made chiefly by the Onondaga Pottery Co.

and the Iroquois China Co., of Syracuse, the Buffalo Pottery Co., of Buffalo, and the Union Porcelain Works, of Brooklyn. Porcelain electric supplies are manufactured by the Empire China Works, Brooklyn, Locke Insulator Co., with plants at Lima and Victor, Pass & Seymour, Syracuse, General Electric Co., and Weber Electric Co., Schenectady. Chemical and sanitary ware are made by the Chas. Graham Chemical Pottery, Brooklyn. The other products include stoneware, red earthenware, cream-colored ware, clay tobacco pipes, etc.

The total value of the pottery produced last year was $2,876,762, as compared with $2,196,054 in 1911. The electric and sanitary wares accounted for $1,727,553, of which the greater part was represented by the value of the electric supplies. The value of certain metal fixtures is included, however, with that of the electric supplies. China or porcelain tablewares accounted for the next highest total, $1,038,428. The stoneware was valued at $46,024 and red earthenware at $29,697. All other products represented a value of $35,060.

Value of production of pottery

WARE	1910	1911	1912
Stoneware	$41 925	$39 095	$46 024
Red earthenware	25 713	32 495	29 697
Porcelain and semiporcelain [1]	1 027 249	1 048 872	1 038 428
Electric and sanitary supplies	991 131	1 026 517	1 727 553
Miscellaneous	50 500	49 075	35 060
Total	$2 136 518	$2 196 054	$2 876 762

[1] Includes china tableware and cream-colored ware.

CRUDE CLAY

The clay produced in a few localities is not utilized by the original producers, but is shipped to others for manufacture, some of it going to points outside the State. This production, therefore, is listed separately from that of clay materials. The clays most extensively exploited for shipment are the Albany slip clay and the fire clay found on Staten Island. The slip clay is a variety of the ordinary glacial clays found in the Hudson valley in association with the brick clays, differing from the latter in its finer grain and higher content of alkaline constituents. It has a relatively low

point of fusibility and when applied to clay wares as a slip, produces a rich, brown glaze. Stoneware clays are shipped in a small way from Onondaga county.

The records for 1912 show that the shipments of crude clay in that year amounted to 8583 short tons valued at $18,980. There were 5 producers engaged in this business. The corresponding total for 1911 was 14,193 short tons valued at $11,982. The difference in value indicated by the totals is accounted for by the varying proportions of the higher priced clays, slip and fire clays, included in the statistics for 1912.

EMERY

The emery business, which is confined to a few small operations near Peekskill, has not been very active in the last year or two. The shipments during 1912, as reported by the companies to whom they were made, amounted to 589 short tons, valued at $6479. In 1911 the shipments were reported as 769 short tons valued at $8810, and in earlier years were still larger, reaching as high as 1500 tons at one time.

The Peekskill emery is a hard, dense rock of rather variable composition and dark gray to black color. It occurs in small lenses, bands and irregular masses in the area of basic igneous rocks that outcrops south and east of Peekskill. The emery bodies are found mainly in the northern section of the area and apparently near the contact of the igneous, or Cortlandt, series with the sedimentary schists. They represent without much doubt segregations within the intrusive mass similar to the titaniferous magnetites that occur within the gabbros and anorthosites of the Adirondacks. The surrounding sediments may have been absorbed more or less into the igneous mass on its way to the surface, thereby contributing some of the aluminum which has crystallized out in the form of corundum and spinel. The intrusion took place after the deposition of the Hudson River strata which are made up largely of argillaceous materials.

The emery is a mixture of corundum, spinel and magnetite, with more or less of the silicate minerals that are found in the wall rocks. The proportion of the oxids varies greatly. In some places magnetite constitutes nearly the whole mass and such bodies have been worked in the past for their iron, though not with much success. Spinel (hercynite) is intimately associated with the magnetite, though its presence is seldom to be established without microscopic examination, being in finely divided particles scarcely distinguishable

from the latter in the hand specimens. Its occurrence may account for the high aluminum percentages shown in analyses of the magnetites, even in the absence of corundum. The latter is a fluctuating constituent, constituting as much as 50 per cent of the emery in places, but usually considerably less. It appears in the form of thin prismatic crystals which are set off by reason of their light color and their relatively large size from the magnetite and spinel.

The mines consist of open cuts on the outcrop of the bodies, occasionally supplemented by a single underground level reached through an adit. They have little permanent equipment, being too small to warrant any considerable outlay for machinery; consequently there is a lack of stability and system to the operations.

The present source of supply is mainly from one or two properties on the northern border of the Cortlandt area. The Keystone Emery Mills and the Blue Corundum Mining Co. have been the principal shippers of recent years. There are a number of mines in the section north of Dickinson hill and south of the east-west highway leading out of Peekskill, but most have been closed either on account of exhaustion or the unsuitable character of the material. Some of the more extensive workings are on the farms of John Buckbee and Oscar Dalton.

FELDSPAR

Feldspar is one of the minor products for which the market in this section hitherto has been rather limited. The pottery trade in which the better or more valuable grades find use has only recently come into prominence in New York, and the larger centers without the State, as those of Ohio, West Virginia and New Jersey, can usually be supplied more cheaply from other sources. Thus the principal quarries of pottery spar are found in New England, the Southern States and Canada. The local quarries in the Adirondacks and the southeastern metamorphic belt have never been able to compete very successfully in this branch of the business.

With the recent growth of the pottery business, now represented in many branches and in various parts of the State, there would seem to be opportunity for development of some of these resources to meet the requirements of the local market.

The uses of feldspar, aside from that of pottery manufacture, are sufficiently varied to afford a basis for regular quarry operations such as are carried on at present. One of the principal applications is in the preparation of roofing material, where it is

employed as a surface coating with tar or some bituminous binder. The spar is crushed to pea size or a little coarser and by reason of its good cleavage yields flat surfaces that are of advantage in securing firm adherence. The purity of the material, however, is a subordinate factor; the pegmatite which contains more or less quartz, mica and other minerals, is crushed down to size just as it comes from the quarry. Besides the roofing grades, there is more or less fine material resulting from the crushing, which is sold for use in concrete and grout. A small quantity of the spar of the coarser size is sold for poultry grit. Crushed pegmatite for these purposes brings a low price, usually around $3 a ton.

The quarries and mills making roofing spar are situated in the Adirondack region, and include those of the Crown Point Spar Co. at Crown Point and the Barrett Manufacturing Co. at Ticonderoga. The methods of milling are simple, being based on a system of gradual reduction and sizing by screens. For the first step, a coarse crusher of the Blake type may be used, followed by rolls. At the mill of the Crown Point Spar Co., a higher grade of spar that is sold to enamel ware manufacturers is made by crushing to fine size in a chaser. The spar is first sent to the Blake machine, is then dried and instead of passing through the rolls, goes to the chaser.

Manufacturers of enamel ware, glazed brick and terra cotta consume considerable quantities of feldspar. The requirements for these purposes are more exacting than for ordinary roofing spar in that the material must be fairly free of iron or iron-bearing minerals and have a relatively low point of fusibility. The feldspar should also be fairly free of admixture with quartz, as the presence of the latter tends to raise the melting point. As soda feldspar or albite fuses at a slightly lower temperature than the potash varieties orthoclase and microcline, it has preference among the glazed brick and terra cotta manufacturers. The spar is prepared by fine grinding by a chaser or a pebble or ball mill, the operations in a pebble mill lasting about 5 hours and reducing the product to a size that over 90 per cent will pass a 100-mesh screen. The glaze is added to terra cotta by dipping or spraying with the prepared slip and then burning in a kiln.

Another use for the local product is in the manufacture of opalescent glass. This requires a spar of about the same quality as that for enamel ware, but may contain more quartz. The material is also ground to about the same size.

A considerable quantity of feldspar is employed as an abrasive, especially in the form of scouring soaps and powders. It is not readily apparent, however, why feldspar should be preferred to quartz for the purpose, unless it is on account of the cleavage which may, like the parting of garnet, provide sharp cutting edges. For scouring materials, the spar is ground to an impalpable powder. Feldspar is also an ingredient of emery, carborundum and corundum wheels, but here it serves rather as a binder than as an abrasive.

The output of feldspar showed a very large gain in 1912. In former years, it has ranged between 10,000 and 15,000 tons, according to the relative market conditions which were fairly stationary. Last year, however, it reached a total of 24,584 short tons, an increase of over 50 per cent in the twelve months, and in value amounted to $106,419. These figures include the unsorted pegmatite that is used for roofing material as above explained. The increase was contributed mostly by the Bedford Feldspar Co., which began operations during the year near the Kinkel quarries. The prices received for the product were on about the usual level: $3 a ton for sized roofing spar, $4.50 a ton for selected crude, and $6 to $8 for the ground spar used for enamel, glass manufacture, etc.

The Bedford Feldspar Co. opened a quarry just north of the Kinkel quarries at the base of the hill that marks the main outcrop of the pegmatite body. The continuation of the pegmatite in this direction was shown by drilling, being covered by soil and earth to a depth of about 15 feet. The present opening consists of a circular pit about 75 feet in diameter and 30 feet deep. A derrick is used to raise the rock to the surface. The pegmatite is somewhat stained and disintegrated in the upper part, but doubtless fresher material will be found in depth. It seems to carry more feldspar and less quartz than the average run of the rock exposed in the Kinkel quarries. The company has a mill at the quarry and all the output is shipped in ground state, to tile, enamel ware and glass manufacturers. The mill is equipped with ball mills and has a capacity of 35 or 40 tons a day.

The Kinkel quarries were operated during the year, but the product was shipped in crude form. The mill has been partly dismantled for the installation of new machinery, which will include pebble mills for the preparation of pottery spar. A considerable quantity of the no. 1 potash spar is stocked at the quarries until grinding can begin. The usual shipments of quartz were made from

these quarries to the Bridgeport Wood Finishing Co., for use as wood filler. In addition, Kinkel & Son grind some quartz at a mill south of the quarries.

The latter company opened a new quarry in the spring of 1912, on the Bullock property, 2 miles south of the Bedford quarries. The opening lies west of the Hobby quarry on a parallel lens or dike. The pegmatite body measures about 30 feet in thickness, strikes northeast and dips 80° northwest. The wall rock as seen near the contact is a mica schist resembling the Manhattan schist farther south. The opening into the hill is about 75 feet long and shows a face 30 feet high. It can be deepened considerably without difficulty, as the present level lies near the summit of the hill. The feldspar differs from the Bedford varieties in that it is practically all of buff or cream-color and is shown by microscopic examination to consist of an intergrowth of microline and albite. The two kinds form alternating bands with the microline predominant, in the proportion of 2 or 3 to 1. In the Bedford quarries, the two varieties are segregated into a red microline and a white albite. There is very little intergrowth of feldspar and quartz and most of the product is shipped as no. 1 grade. The feldspar builds crystals that measure up to 2 or 3 feet in diameter and which occasionally show well-defined faces. The quartz is of smoky appearance. There is some muscovite in their scales and sheets associated with the feldspar, but it is mostly segregated. A black tourmaline and dark red garnet are among the accessory constituents.

GARNET

The production of abrasive garnet in the Adirondack region has continued from year to year with little change. The annual total usually is between 4000 and 5000 short tons, now and then slightly exceeding the latter figure. This seems to indicate a fairly stable market which affords the basis for a small and somewhat specialized industry, but which could hardly accommodate any large additional supplies of the mineral, as have been in prospect at different times, without radical readjustment of the present conditions. So far, no permanent or serious competition has developed as the result of mining operations in other sections of the country. For the last few years, however, there has been an importation of Spanish garnet which fills some of the requirements formerly met by the local product.

The active mines in the Adirondacks are situated in Essex and Warren counties. The North River Garnet Co., with mines and mill on Thirteenth lake, Warren county, southwest of North River, is the principal producer and carries on operations more or less continuously throughout the year. The garnet occurs in disseminated crystals in a hard, gneissoid hornblende — feldspar rock which has to be crushed and subjected to mechanical separation to recover the mineral, the separation being complicated by the slight difference in the gravity of the garnet and hornblende. The separation is effected mainly by jigs of special design and results in a very clean concentrate, with such variation of sizes as is required for abrasive purposes. The deposit, situated on the side of a mountain, is attacked by open-cut quarry methods which by reason of its large size and convenient position admit of great economy in breaking and transporting the rock.

The next most important source of garnet is on Gore mountain, a little west and south of North Creek, and some 4 or 5 miles southeast of the former deposit. The garnet here occurs in a band of dark hornblende gneiss, forming larger crystals than are found anywhere else in the Adirondacks. They measure a foot or even more in maximum diameter. The band of garnet gneiss is relatively narrow and is worked in open pits. The rock is broken down by sledges and the garnet, which has been shattered by regional compression, is readily picked out of the matrix by hand. These quarries are worked only in the open season. They are operated by H. H. Barton & Son Co. of Philadelphia.

Some production has been made from time to time from Garnet peak, in the town of Minerva, Essex county, about 3 miles from North River, on the Indian Lake road. The garnet is in small srystals, but plentifully distributed through the rock. In years past the American Glue Co. has been active at this locality, but made no output in 1912.

The Warren County Garnet Mills, Inc., of Riparius, have recently been active at a locality near Wevertown, south of North Creek. The mineral here is quite different in appearance from that produced in the other mines of this section, being partly granular or compact, rather pale in color, and lacking the tendency to break with smooth surfaces which is characteristic of the crystal garnet. It is also more or less intergrown with a green pyroxene. The material is hand-sorted and prepared for market by grinding to proper size.

Outside the rather limited area that includes the above named localities, the only occurrence of garnet that has recently attracted attention as a basis of mining operations is in northern Essex county, a few miles south of Keeseville. The deposits lie on Mt Bigelow, near the border but within the area of anorthosite — the basic igneous rock that forms the central part of the Adirondacks. They consist of bands, lenses and irregular bunches of granular or seemingly massive garnet which is fairly pure, except for inclusions of green pyroxene. They are inclosed directly within the anorthosite. Some of the bands or lenses as seen on the surface are 40 feet across, nearly solid garnet. They are worked in a rather small way by the American Garnet Co. of New York. A similar deposit is reported from the vicinity of Mt Pokamoonshine, southwest of Mt Bigelow.

The production of garnet by the different mines in the Adirondack region amounted last year to 4112 short tons valued at $117,325, as compared with 4285 short tons valued at $121,759 in 1911. These totals represent practically the extent of the industry in this country. Imports of abrasive garnet were reported by the collectors of customs at Boston and New Orleans, at which ports 548 tons valued at $9271 were received in the calendar year. The imports for 1911 were 693 short tons, with an invoice value of $10,526. With the exception of a small shipment of 1200 pounds from Nova Scotia, probably originating in Newfoundland, the garnet was all imported from Spain.

GRAPHITE

The graphite mines in the Adirondacks last year contributed about the usual product of refined crystalline graphite, but there were fewer developments than for some time. The output was 2,628,000 pounds and represented a value of $142,665. The total for 1911 was 2,510,000 pounds with a value of $137,750. There was little change in prices, the average having been 5.4 cents a pound, against 5.5 cents in 1911.

The American mine at Graphite, owned by the Joseph Dixon Crucible Co., continued as the main producer. This mine has had an enviable record, and is still the most successful of its kind in the State or in this country; it has been the pioneer in all that relates to the technology of treating the disseminated flake graphite which constitutes the principal source of the domestic production.

The Empire Graphite Co., with mines and mill in the town of

Greenfield, Saratoga county, made a small output which was obtained mainly from development work. The deposit has not been sufficiently opened to permit regular operations. At first the company attempted to secure an ore supply by open-cut methods, but owing to the decomposed condition of the outcrop the material thus obtained was unsuited for milling. During the past year an incline shaft was started to develop the deposit in depth. The company has a large concrete mill on the property.

The Saratoga Graphite Co. began operations last season in its mines near Kings Station north of Saratoga Springs.

The mines are open cuts along the outcropping edges of a quartz-graphite schist which occurs in broken areas within the Precambric formations that are otherwise represented by crystalline limestone, quartzite, amphibolite and gneissoid eruptives of granitic and basic character. They lie about one-half mile west of the Saratoga-Mt McGregor highway on the side and top of the ridge that marks the eastern boundary of the Precambrics as they fall off and disappear below the Paleozoic strata which border the Adirondack area. The first outcrop of the graphite rock on the north side of the ravine in which the mill is located shows from 10 to 12 feet in a single bed. The outcrop is much softened and iron stained through the decomposition of pyrite that is present in the fresh rock. This soft clayey material is of little value for milling purposes. The bed dips 30 degrees southeast, nearly parallel with the hill slope. The open cut is 50 feet long and 25 feet in width. Specimens of the less altered schist show an abundance of graphite, but in finely divided condition, most of the scales being less than 1 millimeter diameter. There is some brown mica present. About one-fourth mile farther west and higher up, a second area of the schist appears and has been opened by a pit which is 75 feet long by 30 feet in width. The schist here is not so thinly laminated and contains knots and stringers of feldspar. The beds dip to the southeast at a lower angle than in the easterly pit; they have a pitch to the northwest. The graphite here is somewhat coarser, the diameter of the flakes running up to 2 or 3 mm. The two areas are separated by a rather massive, dark hornblende gneiss that appears to be a metamorphosed gabbro. The output of refined graphite thus far has been small. The mill has the usual equipment of the Adirondack graphite mills. Stamps are used for final crushing and the separation is effected mainly by buddles, supplemented by air jigs and revolving screens for the final treatment.

GYPSUM

There was a noticeable, if not marked, improvement in the gypsum industry last year, as compared with the conditions noted in the preceding issue of this report. The market for gypsum and its products in 1911 was considerably depressed, and instead of showing the usual gain as for previous years, production fell below the total reported for 1910. The main reason for the dulness was the lessened activity in the building trades and the consequent smaller demand for wall plasters, the principal product of the local industry. The companies also reported a falling off in shipments of crude rock, of which the main item is represented by the sales to the portland cement plants and is second in importance only to the consumption by the calcining mills. In both these departments some betterment was apparent during the past season, not only with respect to the demand, but also to some extent in the prices received for the products. The gain came mostly in the latter part of the year and was well maintained to the close. The outlook at the beginning of the current year seemed favorable for the continuance of an active market, at least for the first part of the season.

The output of crude rock by the mines and quarries last year amounted to 506,274 short tons. This was the largest total on record; the next largest was in 1910 when it amounted to 465,591 short tons. In 1911, the output was reported as 446,794 tons. The increase for the year, therefore, was 59,480 tons or about 13 per cent.

The greater part of the output, as heretofore, was used at the mines for the manufacture of stucco and wall plaster. Most of the mining companies operate their own plants for milling and calcining the rock, their output entering the market only in finished form. A few, however, dispose of a part of their product in crushed or ground condition without further preparation, and one company ships all its rock in that form. The portland cement plants of New York, Pennsylvania and New Jersey take most of the raw gypsum, but some is shipped to plate glass manufacturers for bedding the glass sheets in polishing, and a small quantity is sold in ground form for agricultural uses. As it would be difficult to place a value on the rock that is manufactured directly by the producing companies, the plan has been adopted of reporting the total value in terms of the several products as they are marketed. Of the output last year, a total of 178,499 short tons was sold or held for sale as crude rock, as compared with 144,035 short tons thus

sold in 1911. The value of the rock was $240,784 against $202,984 for the preceding year. The quantity ground for land plaster was 8213 short tons with a value of $17,779; as compared with 9959 short tons valued at $18,508 in 1911. The remainder represented approximately the amount calcined for stucco and wall plaster, of which the product amounted to 267,889 short tons valued at $928,282. The corresponding total in the preceding year was 262,249 short tons with a value of $871,106. The total value of the marketable products for the year thus amounted to $1,186,845 as compared with $1,092,598 in 1911.

Production of gypsum

MATERIAL	1911		1912	
	SHORT TONS	VALUE	SHORT TONS	VALUE
Total output, crude	446 794	.....	506 274	.....
Sold crude	144 035	$202 984	178 499	$240 784
Ground for land plaster	9 959	18 508	8 213	17 779
Wall plaster, etc. made	262 249	871 106	267 889	928 282
Total	.....	$1 092 598	.....	$1 186 845

The production of crude rock was contributed by relatively few companies, about ten in all, and was divided among the four counties of Onondaga, Monroe, Genesee and Erie. While in earlier years most of the output was made in the eastern section in Madison, Onondaga and Cayuga counties, by far the greater proportion now comes from the western deposits which are the basis of a prosperous calcining industry. The mines of that section rank with the largest and best equipped of their kind in the country.

In Onondaga county the output has fallen off in recent years, owing to the decline in the land plaster business, to which there has succeeded no commensurate development of other branches. Only one or two quarries are now operated out of the number that have been opened along the extensive outcrop of the beds. The present supply is derived from the vicinity of Lyndon, and mainly from the Severance quarry which has been worked by the Fayetteville Gypsum Co., for supply of rock to calcined-plaster works in New York. The rest of the output from this section was used locally by the land plaster mills at Fayetteville and Jamesville.

The large quarries at Union Springs, Cayuga county, were not active in 1912, but have recently been taken over by the Cayuga Lake Portland Cement Co. for supply of gypsum to their works at Portland Point, near the southern end of Cayuga lake. After pumping out the quarry pit in the spring, active shipments were begun about June 1st. The gypsum is rather low grade, but constitutes such a thick series of beds that it can be extracted very cheaply, and the situation is convenient for shipment to the portland cement plants of eastern Pennsylvania. The rock is taken from the quarry to a mill at the lakeside when it is crushed and loaded into cars.

The mines of Monroe county increased their production during the year, but there was little change otherwise in that section. The county ranked second to Genesee in quantity of rock mined. About two-thirds of the total was calcined at the mines and the rest sold crude to portland cement makers, or ground to land plaster. The Lycoming Calcining Co., the Consolidated Wheatland Plaster Co., and the Empire Gypsum Co. operated calcining plants, while the Oatka Gypsum Co. sold all its output in crude form.

At Mumford, the Delac Gypsum Products Co. did some prospecting and started construction work on a mill for the manufacture of the calcined plasters. The company secured options on the M. Skivington farm north of Mumford, where five test holes were drilled, in all of which gypsum was found. A hole located near the southern end of the property on the flat along Allen creek gave the following section, according to records in possession of Mr Skivington:

Material	Feet	Inches
Surface materials	8	6
Limestone	2	–
Ashes (shaly gypsum)	1	6
Rock	7	–
Gypsum and ashes	3	8
Limestone and ashes	9	4
Gypsum	2	–
Limestone	6	–
Gypsum	5	6
Limestone	8	–
Gypsum	5	–
Limestone	6	–
Ashes	1	6
Gypsum	4	6
Limestone	3	6
Gypsum	4	6
Limestone and ashes	2	6
Gypsum	2	–
Limestone and ashes	2	–
Total depth	85	–

The succession is scarcely comparable with that at Garbutt, the center of the mining industry in this part of the field, where the gypsum rock occurs in two beds, each from 5 to 8 feet thick, separated by a bed of limestone ranging from 6 to 12 feet in thickness.

The principal development in the Oakfield district, Genesee county, was the construction of a new calcining plant by the United States Gypsum Co. The plant has five vertical kettles, a very important addition to the manufacturing capacity of the company already the largest in the State.

On the extreme section of the gypsum belt, near Akron, the American Gypsum Co. maintained its usual operations, but the Akron Gypsum Co. closed its mines and plaster works in the fall. The existence of gypsum to the west of Akron was reported to have been proved by test holes; the discovery has not been succeeded as yet by any developments. A hole put down in the foot wall of the seam at Akron to a depth of 70 feet failed to show any workable deposit, though farther east, in Monroe county, two distinct beds are known to occur.

IRON ORE

Iron mining in the State resulted in about the same output last year as in 1911. There was a better inquiry for ore than the market showed during most of the year before, but prices were not correspondingly higher to furnish the necessary incentive to enlarged operations. No new mines entered upon the producing stage. Exploration and development work, however, continued active, specially in the Adirondack region, and brought to light substantial additions to the resources that eventually should be turned to account.

The production of iron ore during the last two decades is given in the accompanying table. The figures are based on lump ore and concentrates of commercial grades, and not on the mine output, which, by reason of the large proportion that is subjected to mill treatment, is considerably larger. The figures for ten years previous to 1901 have been taken from the volumes of the *Mineral Resources*, and the others compiled from reports submitted by mining companies.

Production of iron ore in New York State

YEAR	MAGNETITE	HEMATITE	LIMONITE	CARBONATE	TOTAL	Total value	Value a ton
	Long tons	Long tons	Long tons	Long tons	Long tons		
1892	648 564	124 800	53 694	64 041	891 099	$2 379 267	$2 67
1893	440 693	15 890	35 592	41 947	534 122	1 222 934	2 29
1894	.....	.....	.....	.....	242 759	.....	.....
1895	260 139	6 769	26 462	13 886	307 256	598 313	1 95
1896	346 015	10 789	12 288	16 385	385 477	780 932	2 03
1897	296 722	7 664	20 059	11 280	335 725	642 838	1 91
1898	155 551	6 400	14 000	4 000	179 951	350 999	1 95
1899	344 159	45 503	31 975	22 153	443 790	1 241 985	2 80
1900	345 714	44 467	44 891	6 413	441 485	1 103 817	2 50
1901	329 467	66 389	23 362	1 000	420 218	1 006 231	2 39
1902	451 570	91 075	12 676	Nil	555 321	1 362 987	2 45
1903	451 481	83 820	5 159	Nil	540 460	1 209 899	2 24
1904	559 575	54 128	5 000	Nil	619 103	1 328 894	2 15
1905	739 736	79 313	8 000	Nil	827 049	2 576 123	3 11
1906	717 365	187 002	1 000	Nil	905 367	3 393 609	3 75
1907	853 579	164 434	Nil	Nil	1 018 013	3 750 493	3 68
1908	663 648	33 825	Nil	Nil	697 473	2 098 247	3 01
1909	934 274	56 734	Nil	Nil	991 008	3 179 358	3 21
1910	1 075 026	79 206	4 835	Nil	1 159 067	3 906 478	3 37
1911	909 359	38 005	5 000	Nil	952 364	3 184 057	3 34
1912	954 320	103 382	Nil	Nil	1 057 702	3 349 095	3 17

The output in 1912, as reported by all the mines that made shipments during the year, was 1,057,702 long tons, valued at $3,349,095. Compared with the total for the preceding year, there was a gain of 105,338 tons, or about 10 per cent, as against a decline of 206,703 tons in 1911. The value of the ore averaged $3.17 a ton, as against $3.34 for 1911; the falling off indicated by these figures was not solely a market decline, but was due in part to the large proportion of hematite shipped during the past year.

Of the output, magnetite constituted a total of 954,320 long tons and represented a value of $3,148,756. The quantity of hematite mined was 103,382 long tons, all from the Clinton belt, with a value of $200,339. There were no shipments of limonite ore from southeastern New York and none of carbonate, although these were actively mined a few years ago.

The output of magnetite was made up largely of concentrates, some of the mines in the Adirondacks shipping all their product in that form. A ton of concentrates, which on the average contains about 65 per cent iron, represents all the way from a little over one to three tons of crude ore. The actual amount of magnetite raised from the mines during the year was 1,174,295 long tons; and the total quantity of ore of all kinds hoisted was 1,277,677. In 1911 the total quantity hoisted was 1,258,873 tons.

The list of companies that were active in the industry last year included for the Adirondack region: Witherbee, Sherman & Co. and the Port Henry Iron Ore Co., Mineville; Cheever Iron Ore Co., Port Henry; Chateaugay Ore & Iron Co., Lyon Mountain; Salisbury Steel & Iron Co., Salisbury Center; and the Benson Mining Co., Benson Mines. The producers of magnetite in southeastern New York were the Hudson Iron Co., Fort Montgomery, and the Sterling Iron & Railway Co., Lakeville. The output of hematite was made by C. H. Borst, Clinton; Furnaceville Iron Co., Ontario Center; and Ontario Iron Ore Co., Ontario Center.

Mineville. The product of the mines at Mineville, the most important center of the industry, was a little below that reported in 1911, in actual figures 675,512 long tons against 734,353 long tons in 1911. Operations were conducted in the same mines as in the preceding year, including the Old Bed, Harmony and Barton Hill groups of Witherbee, Sherman & Co. and 21 and Welch shafts of the Port Henry Iron Ore Co.

The principal feature of the year's record of developments, perhaps, has been the progress of underground and surface work on the Barton Hill properties, as a result of which they have again resumed active production. These mines have contributed a considerable output of high-grade ore in the past, but for many years were neglected on account of the difficulties presented by their somewhat isolated position and irregularity. These difficulties have now been removed to a considerable extent by the driving of a tunnel on the course of the ore and well below the outcrop, which gives access to the lower part of the ore zone and provides an easy haulage way as well as natural drainage for ground above its level; and by the erection of an independent concentrating plant on the side of the hill to treat the output. The mill is the fourth of the series erected by Witherbee, Sherman & Co.; one of the others being erected on the Harmony mines and the two older ones on the Old Bed group.

Cheever mine. The operations at Cheever mine, just north of Port Henry, continued to afford a considerable output of concentrating ore, mainly from the southern section. Some bands of high-grade magnetite have also been encountered, but the main dependence is the leaner material left in the walls in the previous period of activity. The management has been very successful in dealing with the problems incident to the restoration of the old underground workings and in the treatment of the ore on the sur-

face; and though not so large as some of the other Adirondack mines measured by output, the property is technically in the front rank. The surface equipment has been enlarged during the past year by the erection of a storage bin at the foot of the cable road on which the concentrates are lowered to the railroad for shipment.

Ausable Forks. Exploration of the magnetite bodies in the vicinity of Ausable Forks has been under way recently, with substantial results. The work was first directed to the old mines on Cook hill at Arnold where the ore zone has been tested by the diamond drill and by surface excavations for a long distance. A very large tonnage of concentrating ore is now known to exist there. In 1912 operations were conducted in the region to the north of Ausable Forks, beyond the Palmer Hill and Jackson Hill mines, an outlying field that hitherto has received little attention. A well-defined zone consisting of lenses or bands of magnetite arranged in series has been found to exist, a parallel occurrence to that on Cook hill. Of geological interest is the development locally of apatite-rich magnetites that recall the Old Bed ores at Mineville. On the northeastern end of the zone the lenticular or tabular form is less apparent, the bodies showing rather irregular shapes as seen on the surface, and the magnetite is in places a filling or cement to brecciated portions of the syenitic country rock.

Benson Mines. The production by the mines at Benson Mines was limited to experimental runs made for the purpose of testing out the new mill equipment. The plant has been largely rebuilt so as to make it more representative of current practice, and storage capacity provided for 10,000 tons of crude ore in order to insure better conditions of operation during the winter months. The company has also erected a power plant on the Oswegatchie river and will hereafter operate the mines and mill by electricity.

Southeastern New York. In the Highlands district the Hudson Iron Co. and the Sterling Iron and Railway Co. were the only operative companies and each contributed its normal quota.

A new enterprise was started during 1912 on the east side of the Hudson, back of Garrison in Putnam county. The Mt Summit Ore Corporation began exploratory work on a property that up to that time had remained practically undeveloped, though reported as belonging once to the Kingston Iron Ore Co. This property lies on the road to Tompkins Corners, high up on the ridge between the Hudson and the small valley occupied by Sprout brook. The ore is magnetite of granular to compact massive character and

occurs in seams interbanded with the county gneiss; also in disseminated particles through the mass of the rock. The seams, of which the heaviest is 4 or 5 feet thick, are rich in places, but the general run, as shown by the accumulation of material on the surface, is of considerably lower grade. There is little to be seen in outcrop, as in fact exposures in that vicinity are quite limited. The county rock appears to be a laminated biotite-hornblende gneiss that has undergone injection by granite so as to exhibit as much of the latter as of the original mineral aggregate. The granite develops frequently a pegmatitic texture and is accompanied by bands of white vein quartz. The ore seams, with the included rock containing disseminated magnetite, conform in strike and dip. The latter at the surface is about 45° northwest but is said to become nearly vertical at the bottom of the prospecting shaft, which had reached a depth of 165 feet in June 1913. The strike is northeast with the prevailing trend of the Highlands Precambric formations. The company has erected a mill on the property for the purpose of concentrating the ore. The building is of sheet iron and is equipped with crushers, a dryer and magnetic separators. The latter are of the permanent magnet type, said to be a modified form of the Carter apparatus. The ore crushed down to 1.5 inch size, or less, falls in a thin stream in front of the horizontal magnets arranged one above another; the magnetite is diverted from the normal direction of fall by the attraction and passes into a separate receptacle, while the tailings continue their course downward from magnet to magnet without deflection. This method has the objection that the very fine particles of gangue are entangled more or less with the magnetite, as there is no jar or jigging movement to aid in their separation, which is secured by the common types of the drum and belt machines used in the Adirondack mills. To obviate this difficulty it is proposed to equip the last of the series of separators with an air-suction apparatus to draw off the dust from the falling stream of ore and tailings.

MINERAL WATERS

New York has held for a long time a leading position among the states in the utilization of mineral waters. The different springs, of which over two hundred have been listed as productive at one time or another, yield a great variety of waters in respect to the character and amount of their dissolved solids. There are some that contain relatively large amounts of mineral ingredients and

are specially valuable for medicinal purposes; Saratoga Springs, Ballston Springs, Richfield Springs, Sharon Springs and Lebanon Springs are among the more noted localities for such waters. Numerous other springs are more particularly adapted for table use containing only sufficient mineral matter perhaps to give them a pleasant saline taste. Both kinds of waters are generally carbonated and sold in small bottles.

Of late there has developed an important business in the sale of spring waters which can hardly be classed as mineral in the common acceptance of the word, but which are extensively consumed for office and family use in the larger towns and cities. Their employment depends upon their freedom from harmful impurities, in which feature they are generally superior to the local supplies. In so far as such waters are an article of commerce they may well be included in a canvass of the mineral water industry. They are usually distributed in large bottles or carboys in noncarbonated condition.

Character of mineral waters. Among the spring waters that contain mineral ingredients in appreciable quantity those characterized by the presence of alkalis and alkaline earth are the most abundant in the State. The dissolved bases may exist in association with chlorin and carbon dioxid, as in the springs of Saratoga county, or they may be associated chiefly with sulphuric acid, as illustrated by the Sharon and Clifton springs.

The mineral waters of Saratoga Springs and Ballston are found along fractured zones in Lower Siluric strata, the reservoirs occuring usually in the Trenton limestone. They are accompanied by free carbon dioxid which, together with chlorin, sodium, potassium, calcium and magnesium, also exists in dissolved condition. The amount of solid constituents in the different waters varies from less than 100 to over 500 grains per gallon. Large quantities of table and medicinal waters are bottled at the springs for shipment to all parts of the country. The carbon dioxid which issues from the wells at Saratoga is likewise an important article of commerce.

The waters at Richfield Springs contain the elements of the alkali and alkaline earth groups together with sulphuric acid and smaller amounts of chlorin, carbon dioxid and sulphureted hydrogen. They are employed for medicinal baths as well as for drinking purposes. The springs issue along the contact of Siluric limestone and Devonic shales. Sharon Springs is situated to the east of Richfield Springs and near the contact of the Lower and Upper Siluric. Clifton

Springs, Ontario county, and Massena Springs, St Lawrence county, are among the localities where sulphureted waters occur and are utilized.

The Oak Orchard springs in the town of Byron, Genesee county, are noteworthy for their acid waters which contain a considerable proportion of aluminum, iron, calcium and magnesium, besides free sulphuric acid.

The Lebanon spring, Columbia county, is the single representative in the State of the class of thermal springs. It has a temperature of 75° F. and is slightly charged with carbon dioxid and nitrogen.

Ordinary spring waters. The greater quantity of spring waters consumed in the State belongs to the nonmedicinal, noncarbonated class, represented by such springs as the Great Bear, Deep Rock, Mount View, Sun Ray, Chemung etc. The waters are obtained either by flowing springs or from artesian wells and are shipped in carboys or in tank cars to the principal cities where they are bottled and distributed by wagons among the consumers. The essential feature of such waters is their freedom from noxious impurities. This is generally safeguarded by the care exercised in the handling of the waters which are also regularly examined in the chemical and bacteriological laboratories.

Carbon dioxid. This gas is given off in quantity by some of the wells at Saratoga Springs, and its collection and storage for shipment constituted for many years an important industry at that place. Over 30 wells have been bored there for gas alone. The industry has now been discontinued by force of a legislative enactment; it was considered that the pumping of the wells for the production of the gas was detrimental to the other springs that were utilized solely for their waters. For some time the value of the natural gas secured from the wells exceeded that of the mineral water sales.

List of springs. The following list includes the names and localities of most of the springs in the State that are employed commercially, as shown by a canvass of the industry:

NAME	LOCALITY
Baldwin Mineral Spring	Cayuga, Cayuga co.
Coyle & Caywood	Weedsport, Cayuga co.
Diamond Rock Spring	Cherry Creek, Chautauqua co.
M. J. Spicer	West Portland, Chautauqua co.
Breesport Oxygenated Mineral Spring	Breesport, Chemung co.
Chemung Valley Spring	Chemung, Chemung co.
Keeseville Mineral Spring	Keeseville, Clinton co.
Lebanon Mineral Spring	Lebanon, Columbia co.
Mt Beacon Spring	Matteawan, Dutchess co.

NAME	LOCATION
Mount View Spring	Poughkeepsie, Dutchess co.
Ayers Amherst Mineral Spring	Williamsville, Erie co.
Elk Spring Water Co	Lancaster, Erie co.
Beauty Spring Water Co	Lyons Falls, Lewis co.
Mohawk Springs	Amsterdam, Montgomery co.
Cold Spring	New York Mills, Oneida co.
Lithia Polaris Spring	Boonville, Oneida co.
Orville Risley	Whitesboro, Oneida co.
J. Wells Smith	Franklin Springs, Oneida co.
F. H. Suppe	Franklin Springs, Oneida co.
Geneva Lithia Spring	Geneva, Ontario co.
Red Cross Lithia Spring	Geneva, Ontario co.
Crystal Spring	Oswego, Oswego co.
Great Bear Spring	Fulton, Oswego co.
Os-we-go Spring	Oswego, Oswego co.
Mammoth Spring	North Greenbush, Rensselaer co.
Shell Rock Spring	East Greenbush, Rensselaer co.
Madrid Indian Spring	Madrid, St Lawrence co.
Massena Mineral Spring	Massena Springs, St Lawrence co.
Artesian Lithia Spring	Ballston Spa., Saratoga co.
Comstock Mineral Spring	Ballston Spa., Saratoga co.
Arondack Spring	Saratoga Springs, Saratoga co.
Geyser Spring	Saratoga Springs, Saratoga co.
Gurn Spring	Saratoga Springs, Saratoga co.
Chalybeate Spring	Sharon Springs, Schoharie co.
Eye Water Spring	Sharon Springs, Schoharie co.
Gardner White Sulphur Spring	Sharon Springs, Schoharie co.
Sulphur-Magnesia Spring	Sharon Springs, Schoharie co.
Red Jacket Spring	Seneca Falls, Seneca co.
Pleasant Valley Mineral Spring	Rheims, Steuben co.
Setauket Spring	Setauket, Suffolk co.
Elixir Spring	Clintondale, Ulster co.
Sun Ray Spring	Ellenville, Ulster co.
Vita Spring	Fort Edward, Washington co.
Briarcliff Lodge Association	Briarcliff Manor, Westchester co.
Gramatan Spring Water Co	Bronxville, Westchester co.

Production. The returns made by the spring water companies for 1912 showed sales of 9,682,447 gallons valued at $760,847. In the preceding year the sales amounted to 8,923,628 gallons valued at $756,147. There was thus a considerable gain in quantity but a very slight advance in value of the output, which may be attributed to the continued increase of the sales of nonmedicinal or fresh waters over the higher priced carbonated waters. The values as given are based on the wholesale prices at the spring localities, exclusive of the cost of bottling. No account is made of the waters used in hotels, sanitariums etc., run in connection with the springs, though this is an important item in the business in some places. The number of springs used for commercial purposes has declined during the past year or two owing to the inclusion of nearly all the important Saratoga wells in the new State reservation. Several of the wells have been thrown open to public use, but are not utilized for the sale of bottled waters.

Saratoga Springs. The commercial production of carbon dioxid, formerly an important product from the wells at Saratoga, has ceased altogether, as a result of the legal proceedings recently taken against the companies operating wells for the purpose. The lands of these companies also have now been incorporated in the State reservation. Of the large number of springs once so used for gas or for the sale of bottled waters, only a few, like the Arondack, Vichy and Gurn, are still held in private hands. The report of the Commissioners of the State Reservation, submitted in March 1913, indicates that there has been a marked improvement in the flow of many of the wells since the stoppage of pumping operations by private owners.

Of timely interest, in view of the proceedings looking toward the conservation of the mineral waters at Saratoga, is the report by James F. Kemp which appeared during 1912 as Bulletin 159 of the New York State Museum. After an introductory sketch of the historical features connected with the springs, the report describes the local geology in its bearing upon the methods of accumulation and storage of the waters, regarding which various views have been presented by geologists and chemists. There are chapters also on the composition of the springs, the carbon dioxid that accompanies their issue, temperature, gravity, classification, and variations that have been noted in the character of certain springs with the lapse of time. In the discussion of origin, Professor Kemp brings out the various data that appear to be related to the problem, upon which he bases the conclusion that the waters are essentially deep-seated, though taking their content of calcium and magnesian carbonates from the limestones near the surface and mingling with meteoric waters in their ascent. Numerous chemical analyses of the waters are appended to the text.

NATURAL GAS

The natural gas industry of New York has shown surprising vigor during the last few years. The State ranks as one of the first in which this valuable fuel was produced, but the resources have apparently not yet been developed to their maximum capacity, except perhaps in the oil well region which has been more thoroughly prospected than any other section. The gas fields, as distinct from those of oil and gas in the southern parts of Allegany and Cattaraugus counties, are mostly small as to area and by no

means comparable in their yield to some of the natural gas fields of Pennsylvania and Ohio, but they bear evidence of great persistence when once tapped, which is a very important feature.

The production of the State is contributed by sixteen counties altogether, including Allegany, Cattaraugus, Chautauqua, Erie, Genesee, Livingston, Monroe, Niagara, Onondaga, Ontario, Oswego, Schuyler, Seneca, Steuben, Wyoming and Yates. These comprise the section west of the meridian of 77°, with an outlying area on the north and east near the eastern end of Lake Ontario. The existence of natural gas has been demonstrated for a number of other counties, as far north as Jefferson and as far east as Albany, but in too small quantity to have economic importance.

The supply of natural gas is derived from several geologic horizons, from the Potsdam sandstone in the Cambric to the Chemung strata at the top of the Devonic. The more productive formations include the Trenton limestone of the Lower Siluric, the Medina sandstone of the Upper Siluric, and the Portage and Chemung shales with interbedded sandstones belonging to the Devonic. With few exceptions the gas pools now producing occur in one or another of these formations.

The oil fields of Allegany and Cattaraugus counties have contributed, and still do contribute, considerable quantities of gas. The pools are found in sandstones at different horizons in the Devonic, such as the Bradford, Kane, and Elk "sands" of the Chemung. Some of the supply is consumed in the gas engines for pumping the oil, and the remainder is used for lighting and heating in the local towns or is piped to Buffalo. The distribution of the gas is mainly in the control of a few companies, like the Empire Gas & Fuel Co., of Wellsville, the Producers Gas Co., of Olean, and the United Natural Gas Co., of Oil City, Pa. Some of the local towns supplied from the fields are Olean, Andover, Wellsville, Friendship, Hornell and Geneseo. In the northwestern part of Cattaraugus county there is a small field of which Gowanda is the center and which extends across the border into Erie county. The gas is said to occur in the Marcellus and Onondaga formations of the Middle Devonic. The output is distributed by the Gowanda Gas Co. for use in Gowanda. Explorations have been under way recently in northern Cattaraugus county between Gowanda and Cattaraugus where pools are reported at depths from 2500 to 3300 feet in what is supposed to be the Medina sandstone.

In Chautauqua county, the productive area comprises a belt bordering Lake Erie from Silver Creek southwest to the Pennsylvania state line. Until quite recently, the supply has been obtained from wells a few hundred feet deep in the Portage and Chemung beds and the individual output was small, sufficing for a few families at most. Deep drilling during the past few years has resulted in the discovery of more productive pools, lying at depths from 1900 to 2300 feet in what is considered Medina sandstone. Some very large flows have been encountered in the vicinity of Silver Creek, Dunkirk, Forestville, Sheridan and Westfield. These wells are mainly owned by local companies who sell the output in the neighboring towns and villages. The principal operators include the Frost Gas Co., Silver Creek Gas and Improvement Co., South Shore Gas Co., and Welch Gas Co. During the past year, the United Natural Gas Co. has been engaged in exploration in the town of Arkwright east of Fredonia and is reported to have encountered gas in quantity at depths around 2100 feet.

Erie county contains several fields. A few wells have been put down within the limits of Buffalo. East Aurora, Collins, North Collins, Angola and Springville in the southern part are centers of a more or less active industry. Within the last fifteen years a field has been opened east of Buffalo in the towns of Cheektowaga, Amherst, Lancaster, Clarence, Alden and Newstead, which for some time has been the most productive in the State. The gas is found in the Medina sandstone at depths of from 1200 to 1600 feet, and the wells have proved quite persistent producers. It is transported in pipe lines to Buffalo, Tonawanda, Batavia, Lancaster, Depew, Honeoye Falls, and other towns in the vicinity. There are over 200 productive wells in the field.

In Genesee county a prolific field has been developed at Pavilion during the last five years. The gas is found in the same horizon as in Erie county, at depths of about 1700 feet. The Pavilion Natural Gas Co. and the Alden-Batavia Natural Gas Co. are the chief operators in the field and supply the gas to Pavilion, Leroy and Batavia.

In Wyoming county a few wells are in operation at Attica; in Livingston county at Caledonia, Avon and Lima; and in Ontario county in the towns of East Bloomfield and West Bloomfield. Further east in Onondaga county there are wells at Baldwinsville and Phoenix which supply gas for local use. The pools are found in the Trenton shales and limestone. Oswego county marks the

eastern limit of the productive territory, with wells at Pulaski and Sandy Creek.

Production. The value of the natural gas production for the last four years is shown in the accompanying table which attempts also to divide it among the leading districts. The securing of figures from each county or district separately has become a matter of considerable difficulty in the last year or so, owing to the consolidations among the distributing companies who, operating in many fields, do not keep separate records.

The production for the year 1912 had a value of $1,882,297 and was much the largest that has been reported. The gain over the yield for 1911 was more than 20 per cent. That the increase really reflected a growth of the industry, not a mere rise of prices, is demonstrated by the returns of the companies in regard to the well flow which amounted to 6,564,659,000 cubic feet as compared with 5,127,571,000 cubic feet in 1911, 4,815,643,000 cubic feet in 1910 and 3,825,215,000 cubic feet in 1909. These amounts include estimates for some of the smaller producers who have no meters attached to their mains, but they are close approximations to the actual yield.

The average price received for the gas sold for general consumption was 28.7 cents a thousand in 1912, against 30 cents in the preceding year. This indicates a slight decrease in price, but may be accounted for largely by the larger gain of output in the western fields where the gas brings a relatively low price and little or no gain in the outlying districts that are favored by higher prices.

Production of natural gas

COUNTY	1909	1910	1911	1912
Allegany-Cattaraugus	$282 964	$337 427	$402 931	$1 503 274
Chautauqua	174 597	202 754	222 023	263 742
Erie [1]	461 531	717 038	813 279	[4]
Livingston [2]	59 888	60 997	73 357	81 740
Onondaga	12 310	12 733	12 972	14 260
Oswego	14 402	14 783	14 913	16 366
Wyoming [3]	40 001	65 967	7 602	2 915
Total	$1 045 693	$1 411 699	$1 547 077	$1 882 297

[1] Includes output of Genesee county for 1911 and part of it for the preceding years.
[2] Includes also Seneca, Schuyler, Steuben, Ontario and Yates.
[3] Includes Niagara and also some of Genesee except for 1909 and 1910.
[4] The production of Erie and Genesee counties in 1912 is included under Allegany-Cattaraugus.

The reports for the year 1912 covered a total of 1660 wells, besides the oil wells of Allegany and Cattaraugus counties that produce gas as a by-product.

Erie county has the largest output of any county in the State, but owing to the conditions obtaining there in the commercial distribution of the gas, its product for 1912 can not be definitely stated. Its output, with that of Genesee county, is included under Allegany-Cattaraugus counties. These four counties together contributed a total of 5,294,478,000 cubic feet with a value of $1,503,274. The district east of Buffalo continued to be the main producer in Erie county, but the most important developments of the year took place in the vicinity of Orchard Park, town of East Hamburg, south of that city. The Orchard Park Gas Co. drilled the first well in April, which was followed rapidly by others put down by the same company and by the Buffalo Natural Gas Co. Altogether 20 wells have been drilled, indicating a rather small but quite productive pool in that vicinity. The Iroquois Gas Co. of Buffalo took over, during the year, the interests and franchises of the United Natural Gas Co., one of the larger operators in the western fields, and also those of several of the smaller companies in Erie county.

In Chautauqua county, the lake shore district maintained its activity and yield. New wells were drilled by the Frost Gas Co., near Silver Creek; by the United Natural Gas Co. and its successors, the Iroquois Gas Co., in Arkwright township, and by other companies.

Good wells are reported to have been brought in at Red House, Cattaraugus county, the yield having been around 1,000,000 cubic feet a day.

PETROLEUM

The year 1912 witnessed exceptional conditions in the petroleum fields of the State. In the face of steadily advancing prices, production fell to the lowest stage reached since systematic developments were started in the Allegany county district about thirty-five years ago. Considered by itself, this seemingly discouraging situation might lead to the impression that the oil industry had nearly reached the end, so far as the local crude supplies are concerned; or at least that the latter were no longer capable of a sustained output. A study of the statistics of prices and production for the few preceding years, however, indicates that the decline

may be explained rather by economic considerations than by the failure of the natural resources.

As a matter of fact, the oil pools long since reached their maximum capacity for production, but by continued redrilling of the proved territory the yield for the last two decades has been fairly well maintained. The oils are mostly of superior quality with a paraffin base, characteristic of the Appalachian fields, and bring the highest prices in the market, so that under normal conditions the industry is remunerative, even though the yield for each well is very small.

The average output until recently has remained nearly constant at a little over a million barrels a year. Fluctuations have depended mostly upon the state of the market. A severe slump in the latter took place in 1910, the prices declining steadily from month to month until the reduction amounted to over 50 cents a barrel. This practically put an end to development work, and pumping operations at many of the less productive wells were stopped. The effects of this depression were noticeable to some extent in the returns made for the year 1911, but the full force of it became manifest in last year's total.

With the falling off in yield which affected the Appalachian districts generally, prices began to strengthen and from the low point of $1.35 a barrel in January advanced steadily throughout the remainder of the year, reaching the price of $2 a barrel at the close. This was higher than New York crude sold for previous to the decline of 1910, so that development work should once more resume its normal course. An improvement in the productive industry may be anticipated for the current year, unless conditions show a sudden reversal.

The output of oil in the State during the last two decades is given in the accompanying table. The figures for the years 1893–1903 have been taken from the annual volumes of "The Mineral Resources" and those for the following years compiled from reports rendered by the pipe-line companies and shippers who operate in the State. The list of these companies is as follows: the Allegany Pipe Line Co., Columbia Pipe Line Co., Union Pipe Line Co., and Fords Brook Pipe Line Co., of Wellsville; Vacuum Oil Co., of Rochester; New York Transit Co., of Olean; Emery Pipe Line Co., Kendall Refining Co., and Tide Water Pipe Co., Limited, of Bradford, Pa.

Production of petroleum in New York

YEAR	BARRELS	VALUE
1893	1 031 391	$660 000
1894	942 431	790 464
1895	912 948	1 240 468
1896	1 205 220	1 420 653
1897	1 279 155	1 005 736
1898	1 205 250	1 098 284
1899	1 320 909	1 708 926
1900	1 300 925	1 759 501
1901	1 206 618	1 460 008
1902	1 119 730	1 530 852
1903	1 162 978	1 849 135
1904	1 036 179	1 709 770
1905	949 511	1 566 931
1906	1 043 088	1 721 095
1907	1 052 324	1 736 335
1908	1 160 128	2 071 533
1909	1 160 402	1 914 663
1910	1 073 650	1 458 194
1911	955 314	1 251 461
1912	782 661	1 338 350

The total production in 1912 amounted to 782,661 barrels, as compared with 955,314 barrels in 1911. The decrease was 172,653 barrels, or about 20 per cent. The output in 1910, which was 1,073,650 barrels, showed a drop of 158,336 barrels or about 15 per cent from that of 1909 when the first break in the market prices began. The value of the output last year was $1,338,350, an average of $1.71 a barrel, against $1,251,461 or an average of $1.31 a barrel in 1911 and $1,458,194 and an average of $1.36 in 1910 and $1,914,663, an average of $1.65 in 1909.

The record of field work as compiled monthly by the Oil City Derrick showed that 246 wells were drilled in the New York fields during 1912. This figure indicates a slightly increased activity over the preceding year, when the number completed was 195. The number of wells completed in 1910 was 283 and in 1909, when conditions were more normal, the number was 457. The increment of production from the new wells amounted to only 278 barrels, as compared with 201 barrels in 1911, 368 barrels in 1910 and 715 barrels in 1909. Of the number of wells completed, 66 were dry against 59, 61 and 32 respectively in the preceding years.

The oil pools found in the State constitute the northern extension of the Appalachian field which reaches its main development in

Pennsylvania, Ohio and West Virginia. They underlie small areas in Cattaraugus, Allegany and Steuben counties near the Pennsylvania border. The first well was drilled in Cattaraugus county in 1865, and Allegany county began producing about 1880. The oil is found in fine-grained sandstones of dark color belonging to the Chemung formation of the upper Devonic. In Cattaraugus county the productive area embraces about 40 square miles, mostly in Olean, Allegany and Carrolton townships. The pools of which the principal ones are the Ricebrook, Chipmunk, Allegany and Flatstone, occur at several horizons from 600 to 1800 feet below the surface. The oil district of Allegany county extends across the southern townships of Clarksville, Seneca, Wirt, Bolivar, Alma, Scio and Andover and is divided into several pools that are considered to be more or less independent. The Bolivar, Richburg and Wirt pools have been most productive. The oil is found at depths of from 1400 to 1800 feet. The Andover pool lies partly in the town of West Union, Steuben county, and is accountable for the production in that section. The reports of the "Mineral Resources" covering the year 1910 showed a total of 10,995 productive wells in the State, of which number Allegany county had 7859, Cattaraugus county 2917 and Steuben county 219. Practically all the wells are pumped and the average yield is less than one-third of a barrel a day.

There has been a great deal of exploration outside the districts mentioned, but up to the present time has not led to any positive additions to the productive area. Some of the more interesting and promising developments have been in northern Allegany county. A discovery of oil was reported a few years since in the town of Granger on the Livingston county border, considerably north of the other pools, and about 30 wells were drilled as a test. Some of these flowed under natural pressure, but they soon gave out, yielding less than 3000 barrels altogether. In the last year or two another section near Swain, town of Grove, has been under exploration. The original discovery was reported on the Fred Bennett farm where oil and gas were encountered in a well put down to 740 feet depth. Some other holes in the same vicinity were dry. Recently drilling has been under way on the Harman place, and two productive wells are reported to have been brought in of which the first produced from 5 to 6 barrels a day. The second was dry when drilled, but began to flow after having been "shot." The oil is said to be of a dark, heavy quality.

PYRITE

The pyrite deposits of St Lawrence county contributed an increased output of that mineral last year, though no new properties were under operation. The main factor in the industry was the St Lawrence Pyrite Co. at Stellaville where it owns extensive mining properties inclusive of the Stella, and a large mill for concentrating the ore. The company only recently attained its present stage of productive activity which places it among the more important producers and shippers of pyrite in the country. The output is mainly in the form of concentrates with a content of 40 per cent or more in sulphur, but a small proportion is shipped as cobbed ore or spalls, with a somewhat smaller tenor of sulphur. The pyrite is used by acid burners in the eastern states, and is considered a very desirable material for their purposes on account of its relative freedom from arsenic and other injurious impurities.

The Hinckley Fibre Co. continued work at the Cole mine near Gouverneur, making shipments of the crude pyrite to its sulphite pulp mills in the Adirondacks. The company has developed a process by which the low-grade material as it comes from the mine can be utilized successfully for making sulphurous anhydride and calcium sulphite, of which very large quantities are employed in the local pulp mills. It would appear that an extensive market for the St Lawrence county pyrite might be developed if the crude ore were generally applicable to sulphite manufacture.

An occurrence of pyrite in the town of Fowler, southeast of Gouverneur, received some attention during the year, and shipments of a few tons of the ore were made for experimental purposes. The locality from which the ore was taken is on the Kilburn place, near Little York. A band of quartz-amphibolite schist, apparently a part of the sedimentary or Grenville series, can be followed in outcrop for a mile or more, its surface being deeply stained by iron oxids. Pyrite occurs more or less abundantly scattered all through the schist and in places forms richer veinlike bands or irregular aggregates which are also distinguished by the coarse character of the mineral. Shallow pits have been sunk at one or two points from which the ore for experiment was taken. The deposits, like many of the other Adirondack occurrences, contain pyrrhotite along with the pyrite, but the former mineral is most in evidence in the southern part of the ore zone.

SALT

The production of salt is one of the larger and more stable branches of the mineral industry and has been carried on in New York State for upwards of a century. The occurrence of rock salt is widespread in the central and western counties, south of the Salina outcrop, but its exploration through mine shafts or wells is restricted to a few places that possess natural advantages for conducting these operations and for marketing the product. At present, 6 counties contribute to the output, with a total of about 30 individual mines and evaporating works.

Few changes in the industry have taken place recently and it is hardly to be expected that any notable developments will occur in the near future. The productive capacity of the local plants long since reached or passed the point of equilibrium with the market requirements. This condition has caused keen competition and brought about the extinction of some of the smaller and less favorably situated enterprises. The industry as a whole, however, seems to be on a firm basis and except for some uncertainty as to the results of the new tariff which proposes to remove the duty on foreign salt, the outlook for the immediate future is more encouraging than it has been in several years.

Reports from all the companies operating last year showed a production of 10,502,214 barrels of 280 pounds. This was the largest total that has ever been returned for a single year, the next largest having been in 1910 when it amounted to 10,270,273. Compared with the output of 10,082,656 barrels in 1911 there was a gain of 419,558 barrels or about 4 per cent. Converted to a tonnage basis, the product last year was equivalent to 1,470,309 short tons, against 1,411,572 short tons for 1910.

The value of the salt production as fixed by the figures reported by the companies was $2,597,260, exclusive of the cost of package and freight to market. From this, an average of 24.7 cents a barrel is obtained for the whole amount. The prices received for evaporated salt were generally higher than in the preceding year and in fact in any other year since 1907. Under the highly competitive conditions that have existed in the local markets as well as in those of other states where the New York producers have a foothold, prices had slumped steadily during the previous few years. In 1911, the average value was only 21.7 cents, whereas it was 22 cents in 1910, 23.3 cents in 1909, 23.7 cents in 1908 and 25 cents in 1907.

It is to be noted that the average values as given are for the

entire amount of salt taken from the mines and wells, and that a certain and not inconsiderable part of this amount represents the salt contents of brine which is not evaporated, but converted directly into alkali products. On this part of the output a very low valuation, representing practically the mere cost of pumping, is placed. The production of this brine is confined to a single company, the Solvay Process Co., which has a number of wells in the town of Tully, Onondaga county, whence the brine is carried by pipe line to the alkali works near Syracuse.

The accompanying tables give the statistics of the salt production for recent years. For the years 1911 and 1912 the output is given according to grades, so far as the classification could be made without revealing the individual figures. The grades depend upon methods of manufacture and purposes for which the salt is used. Rock salt and salt in brine consumed by the alkali industry appear in the last item of the detailed tables which also includes small quantities of evaporated salt not specially classified in the returns. The evaporated salt is chiefly marketed under the grades of common fine, table and dairy, common coarse, common solar, and packers salt. Table and dairy salt includes the finest grades of artificially evaporated salt specially prepared for the table and for butter and cheese making; it brings the highest market price. Under common fine are listed the other grades of fine, artificially evaporated salt that are not specially prepared. Common coarse represents the coarser product from artificial evaporation. Coarse solar salt is made by evaporation of brine in shallow pans exposed to the sun's heat. This process is employed only by the manufacturers in Syracuse and vicinity, and can be carried on, of course, only in the summer months. Packers salt includes the product sold to meat packers and fish salters.

Production of salt by grades in 1911

GRADE	BARRELS	VALUE	VALUE A BARREL
Common fine [1]	1 143 886	$328 127	$.29
Common coarse	285 407	96 968	.34
Table and dairy	1 312 000	629 581	.48
Coarse solar	434 414	131 247	.30
Packers	40 721	11 402	.28
Other grades [2]	6 866 228	994 160	.14
Total	10 082 656	$2 191 485	$.217

[1] Common fine includes a small quantity of common coarse.
[2] Include rock salt, salt in brine used for soda manufacture, and small amounts of brine salt for which the uses were not specified in the returns.

Production of salt by grades in 1912

GRADE	BARRELS	VALUE	VALUE A BARREL
Common fine [1]	1 408 543	$519 844	$0.37
Common coarse	204 136	82 880	.41
Table and dairy	1 353 643	819 103	.61
Coarse solar	296 814	103 886	.35
Packers	72 771	30 564	.42
Other grades [2]	7 166 307	1 040 983	.15
Total	10 502 214	$2 597 260	$.247

[1] Common fine includes a small quantity of common coarse.
[2] Include rock salt, salt in brine used for soda manufacture, and small amounts of brine salt for which the uses were not specified in the returns.

The output in 1912 was contributed by 30 mines and works distributed among 6 counties of the State. Onondaga county was represented by the largest number of producers, having 20 in all. Livingston county was represented by 3, of which 2 were rock salt mines, the only ones now active. Schuyler, Tompkins and Wyoming counties each had 2 producers, and Genesee county had 1.

Production of salt in New York since 1887

YEAR	BARRELS	VALUE
1887	2 353 560	$936 894
1888	2 318 483	1 130 409
1889	2 273 007	1 136 503
1890	2 532 036	1 266 018
1891	2 839 544	1 340 036
1892	3 472 073	1 662 816
1893	5 662 074	1 870 084
1894	6 270 588	1 999 146
1895	6 832 331	1 943 398
1896	6 069 040	1 896 681
1897	6 805 854	1 948 759
1898	6 791 798	2 369 323
1899	7 489 105	2 540 426
1900	7 897 071	2 171 418
1901	7 286 320	2 089 834
1902	8 523 389	1 938 539
1903	8 170 648	2 007 807
1904	8 724 768	2 102 748
1905	8 575 649	2 303 067
1906	9 013 993	2 131 650
1907	9 657 543	2 449 178
1908	9 005 311	2 136 736
1909	9 880 618	2 298 652
1910	10 270 273	2 258 292
1911	10 082 656	2 191 485
1912	10 502 214	2 597 260

The large number of producers in Onondaga county is incident to the solar salt industry which is carried on extensively around Syracuse. The brine used by the solar evaporating works or salt yards is stored in glacial gravels and is pumped and distributed by central plants. The principal supply comes from the old Onondaga Salt Springs Reservation that was sold by the Indians to the State in 1788. The manufacture of salt was placed under State control in 1797 from which time complete records of the industry are available. At one time artificial evaporation was extensively practised but this has been given up almost entirely in recent years with the increased competition from other districts. The solar salt is sold through the agency of the Onondaga Coarse Salt Association.

With the exception of the salt made at Syracuse, the entire production is obtained from the deposits of rock salt which are found in the Salina formation, a succession of shales and limestones with intercalated beds of gypsum and rock salt. The Salina strata outcrop in an east-west belt across the State from Albany county to the Niagara river and is represented by a smaller separate area in southeastern New York. Well tests indicate that the salt deposits are restricted to the western section of the main belt beginning in Madison county; east of there the strata diminish in thickness to such an extent as to preclude their existence. They are encountered only at a depth of 1000 feet or more where there has been sufficient cover to protect them against solution by ground waters. As the whole stratified series has a dip uniformly toward the south, the mines and wells are all located on the southern side of the outcrop which lies about on the line of the 43d parallel. The dip averages 40 or 50 feet to the mile. The most easterly point where rock salt has been found is at Morrisville, Madison county. Between that place and Lake Erie it has been shown to exist in almost all counties of the middle tier.

The exploration of the rock salt beds dates from 1878 when a well bored for oil near Wyoming, Wyoming county, encountered 70 feet of salt at 1270 feet from the surface. Discoveries were subsequently made at Warsaw, Leroy, Rock Glen, Batavia and numerous places in Livingston, Wyoming and Genesee counties. Practically the whole valley of Oatka creek, from Leroy to Bliss and the Genesee valley south of Monroe county has been found to be salt-bearing. The region is now the most productive in the State. Livingston county has the largest annual output which is contributed by the two rock salt mines at Retsof and Cuylerville

owned respectively by the Retsof Mining Co. and the Sterling Salt Co., and by the evaporating plant of the Genesee Salt Co., at Piffard. The other companies now active in this section include the Leroy Salt Co., of Leroy; the Rock Glen Salt Co., of Rock Glen; and the Worcester Salt Co., of Silver Springs.

In Schuyler county salt is obtained around Watkins. The Glen Salt Co. sank the first well there in 1893 and encountered a deposit at 1846 feet depth. The plant is now operated by the International Salt Co. The Watkins Salt Co. also has works at this place.

A well drilled at Ithaca, Tompkins county, in 1885 passed through seven beds of salt aggregating 248 feet in thickness at depths below 2244 feet from the surface. The discovery was followed by active developments at Ludlowville in 1891 by the Cayuga Lake Salt Co., and at Ithaca in 1895 by the Ithaca Salt Co. The plants were taken over in 1899 by the National Salt Co., which was merged in 1905 into the International Salt Co. The Remington Salt Co. later erected a plant at Ithaca which is now in operation obtaining its salt from three wells at a depth of about 2100 feet.

The Solvay Process Co. derives its supply of brine from a number of wells located in the town of Tully, 20 miles south of Syracuse. The brine is carried in pipe line to the works at Solvay.

In Erie county rock salt has been found at Eden Valley, Springville, Perry and Gowanda, but there is no output at present in that county. Among the localities where discoveries have been made may be mentioned Vincent and Naples, Ontario county; Dundee, Yates county; Seneca Falls, Seneca county; and Aurora, Cayuga county. None of these deposits are worked. A well put down in 1909 in the town of Burns, Allegany county, is reported to have passed through 75 feet of clean unbroken salt at 3050 feet depth.

SAND AND GRAVEL

The production of sand and gravel for use in engineering and building operations, metallurgy, glass manufacture, etc., is an important industry involving a very large number of individual operations. The building stone business is specially extensive as there are deposits suitable for that purpose in every section of the State, and nearly every town or community has its local source of supply. Such sand, of course, possesses little intrinsic value. The deposits of glass sands and molding sands are more restricted in their distribution and their exploitation is the basis of a fairly stable industry; certain molding sands are even shipped to distant points, as in the case of those obtained in the Hudson River region.

The sand and gravel beds of the State are mainly of glacial origin, as the whole territory within the limits of New York, in common with the northern section of the United States east of the Rocky mountains, was invaded by the Pleistocene ice sheet which removed all the loose material accumulated by previous weathering and erosion, and left in its retreat a mantle of transported boulders, gravels, sands and clays. In places these accumulations have the character of unmodified drift or morainal accumulations in which the materials are more or less intermixed, and are then of little industrial value. But more generally the deposits show a sorted stratiform arrangement due to having been worked over by the glacial streams and lakes. Such is the condition in many of the larger valleys like those of the Hudson, Champlain and Genesee where sands, gravels and clays occur separately in terraced beds extending far above the present water level. Later water action may have effected a beneficial re-sorting of the materials as instanced by the beach sands of Long Island and some of the lakes in the interior of the State.

A measure of the importance of the sand and gravel industry may be had from the accompanying table which, however, lacks something in the way of completeness and accuracy. The figures relating to the molding sand production are believed to be a close approximation to the actual totals, but those for building sand and gravel may vary considerably from the true quantities, perhaps understating them by as much as 25 per cent. The building sand operations are so widely scattered and in many sections carried on in such haphazard or fugitive manner that it is extremely difficult to cover them all in a statistical canvass.

Production of sand and gravel

MATERIAL	1910	1911	1912
Molding sand	$424 015	$420 780	$422 148
Core and fire sand	33 709	27 484	55 910
Building sand	1 016 598	*b* 750 000	1 156 002
Other sand *a*	65 835	*b* 50 000	*b* 75 000
Gravel	589 551	479 103	840 669
Total	$2 129 708	$1 727 367	$2 549 729

a Includes glass sand, filter sand, engine and polishing sand.
b Partly estimated.

Molding sand. The business connected with the locating, digging, grading and shipment to market of molding sands involves a degree of skill and experience on the part of the operator that makes it a rather specialized branch of the industry. Sands possessing the requisite qualities for employment in the molding of metals are also rather restricted in distribution. The business, therefore, has elements of stability and permanency not shared to any extent by most of the other branches.

The main output of molding sands in New York comes from the middle Hudson valley. The deposits that are actively worked extend along both sides of the river from Washington and Saratoga counties on the north to Orange and Dutchess counties on the south. The product is often spoken of as "Albany" molding sand, probably owing to the fact that Albany is near the center of the district. Albany county furnishes a large part of the output, most of which is dug in the southern townships of Bethlehem and Coeymans.

Throughout the region there is much similarity in the occurrence of the sand. It is always found directly below the soil, and where this is lacking, as in the sand dune tracts of Albany and Schenectady counties, the sand is also absent. The thickness of the soil cover, which has the character usually of a sandy loam, well sodded, averages about one foot. There is no sharp division between soil and molding sand, the change being manifested by a gradual decrease of plant fibers and carbonaceous matter as the valuable layer is reached. The underlying material consists of sand that is sometimes difficult to differentiate from the molding sand itself. As a matter of fact, there are no fixed standards determining the selection, and there is considerable variation in the physical qualities of the sands shipped by the different producers. The most valuable grades consist of the very fine sands which can be used for brass and stove castings; they are consequently most sought for and may be exploited exclusively even when accompanied by coarser kinds that have a more limited sale.

The most notable feature of the distribution geologically is that the sands occupy the site of the glacial Lake Albany. This lake, formed in late Pleistocene time, reached well up the slopes of the middle Hudson valley and the confluent branches and was fed by the flood waters resulting from the melting of the ice sheet in its northward retreat. These waters washed down the rock-waste of clays, sands and gravels made by the erosion of the ice and brought

them into the lake when they were laid down in more or less sorted and stratified deposits. The deltas of the Mohawk and other large tributary streams of that period furnish the principal supplies of the molding sand.

The typical product of this region, that is the finer grades, is characterized by a degree of comminution and angularity of the particles unusual to water-worn sands. It is probable that these features are the result of ice erosion in the first place, but they may have been further developed by wind action after the retreat of the waters and before the deposits became fixed in place by vegetation. At least there are indications in places that the winds effected the final sorting and have deposited the sands in their present attitude which is quite different from that resulting from water work.

The molding sand does not mark the outcrop of any definite layer or layers within the series of interstratified clays and sands, but forms a mantle that follows the surface configuration. It rises and falls with the minor irregularities of the surface, showing a variation of elevation inconsistent with the regular order that would be expected from a water-laid deposit. The thickness of the molding sand is also quite variable, running from a few inches in some places to several feet in other localities. These features have recently been remarked by Stoller,[1] who bases on them a theory as to the secondary origin of the molding sand through the operation of surface agencies, specially oxidation and moisture. "It appears to be a necessary inference from this that surface conditions are a determining cause in the origin of the layer of molding sands. In dry seasons of the year when the surface soil has been largely deprived of water by evaporation, an upward movement of the ground water by capillarity takes place. If the ascending ground water carries iron in solution, the iron may be oxidized and precipitated as it approaches the surface. In this way, the film of iron oxid coating the particles of sand is formed. The porosity of sand, admitting air to a considerable depth below the surface and at the same time favoring evaporation, facilitates the process. In addition to the iron, it is probable that small particles of clay are carried upward by the moving ground waters and are fixed through cementation by the iron oxid. These processes continue from season to season through a long period of years, the layers of molding sand being periodically added to at the bottom until it

[1] Glacial Geology of the Schenectady Quadrangle. N. Y. State Mus. Bul. 154, p. 24 and 25.

attains such a thickness that surface influences no longer penetrate it."

That the weathering action incident to exposure of the sand to oxidation, hydration and physical agencies does work a beneficial change upon the molding sand admits of little doubt, though there is much uncertainty as to just what the process and its importance may be. It is, however, not simply a product of weathering upon the ordinary water-laid sands of this section, but the salient features of its occurrence and origin, at least in some places, are to be ascribed probably to the action of wind. The somewhat patchy distribution; the occurrence without relation to any horizon, but following the surface contours at least in minor undulations; the variable thickness; and the marked angularity of the quartz particles are suggestive of wind agency in the final accumulation of the deposits.

The main part of the product of the region, as stated, consists of the finer sizes. The companies who operate on a permanent basis and in various sections usually are able to supply the various grades for which a market demand exists. The grades are not standardized and their designation by different shippers lacks uniformity. Some five or six are shipped at present. They bear numbers, beginning with zero which represents fine brass sand and running up to no. 4 which is rather coarse. Perhaps the grade most shipped is no. 1 or stove-plate sand. A screen test on a representative sample of this grade from Selkirk gave the following results: through 100 mesh, 96.64 per cent; on 100 mesh, 2.62 per cent; on 80 mesh, .39 per cent; on 60 mesh, .04 per cent; on 40 mesh, .07 per cent; on 20 mesh, .21 per cent.

Aside from the Hudson River region, there is some molding sand obtained in the western part of the State, mainly in Erie and Chautauqua counties. The output there amounts to a few thousand tons a year.

For the year 1912, the returns received indicate a total production for the whole State of 469,138 short tons with a value of $422,148. The total has not varied much in recent years, having been 476,014 tons valued at $420,780 in 1911 and 471,351 tons valued at $424,015 in 1910.

Core sand used in connection with molding sand for the cores of castings is chiefly produced in Erie and Oneida counties. The product is listed with fire sand, the combined production of the two kinds last year amounting to 87,525 short tons valued at $55,910.

Glass sand. Sand for glass manufacture is obtained from the beach sands of Oneida lake and Long Island. The crude sand undergoes purification by washing to remove the clay, mica, iron oxid, organic matter, etc. The manufacture of window glass, once an important industry in the central part of the State in the vicinity of Oneida lake where the sand was obtained, is no longer carried on, as competition with the industry in regions more favored by fuel supplies rendered it unprofitable. The small product of a few thousand tons is shipped elsewhere for manufacture.

Building sand. The use of sand and gravel in building and engineering work calls for enormous quantities of these materials. The business of excavating and transporting them to market is a purely local one, except in certain parts of Long Island from which the supply for New York and its environs is mostly obtained.

A complete census of the sand industry can be obtained only with an outlay of labor and expense which the results would hardly justify. The figures given herewith are simply an approximation based on reports received from producers operating in the principal localities which sustain a more or less steady output. They no doubt understate the total, as there are a large number of small producers who do not report.

The combined value of the sand and gravel as returned for the year 1912 was $1,996,671. The total for the preceding year was $1,229,103. Of the amounts named, $1,156,002 represents the value of the sand and $840,669 that of gravel. Nassau county alone had an output of 2,411,866 cubic yards of sand and 546,687 cubic yards of gravel with a combined value of $1,539,621.

SAND-LIME BRICK

The sand-lime brick manufacturers experienced a very successful season in 1912, as evidenced by their large output. They were favored by an active demand for structural materials that obtained throughout most sections of the State, and it would appear also that the material has been gaining in popularity since its rather recent appearance on the market. There were fewer plants operated than in earlier years, but the average production was considerably larger.

The number of brick made within the year was 21,231,000, as compared with 15,178,000 in 1911. The total has never been exceeded; the largest output previously was in 1906 when it numbered 17,080,000. The value of the product for the last season was

$133,736, or an average of $6.30 a thousand. In the preceding year the value of the outturn was $92,064, an average of approximately $6 a thousand.

The active manufactures included the following: Buffalo Sandstone Brick Co., with a plant at Lancaster; Dyett Sand-Lime Brick Co., Port Jefferson; Glens Falls Granite Brick Co., Glens Falls; Paragon Plaster Co., Syracuse; and Rochester Composite Brick Co., with plant at Brighton. The Sandstone Brick Co.'s plant at Schenectady was inactive, but will probably resume operations during the current season.

STONE

The quarrying of stone and its preparation for the varied requirements of building, engineering construction, etc., holds a prominent place in the industrial activity of the State, and the value of the annual contribution ranks second only to that of clay among mineral materials. No other mineral industry includes so many individual enterprises or is so widely represented in the different sections. The resources are abundant and varied, comprehending all the principal varieties known to the trade. The greater number of quarries, however, are opened in the limestones and sandstones and supply material chiefly for engineering work, highway improvement and such purposes which do not entail any considerable amount of elaboration previous to shipment. In the development of the building, monumental and ornamental branches the local industry has not attained the relative importance that it deserves by reason of the natural wealth of materials adapted to those uses and the advantages for marketing; herein lies, it would appear, the principal field for future enterprise.

The statistics of production which have been collected from year to year show that the industry in general remains practically stationary; in fact lately it has taken a downward trend, falling below the average level of earlier years. This has been due in part to the recent business reaction that has affected practically all industries and in part undoubtedly to the gaining favor of cement and concrete for certain construction purposes. The latter has manifested itself particularly in the loss of trade among the bluestone quarries which supply flagstone to New York and other eastern cities. This branch of the industry has shown a marked decline in the last few years.

The total value of the stone quarried in 1912 was $5,718,994, as compared with a reported value of $5,560,355 in 1911. This indicated a gain of $158,639 or about 3 per cent for the year, against

a decrease for the preceding year of $737,940 or 12 per cent. It should be noticed that the totals as given are not inclusive of slate, millstones or limestone used for cement manufacture, which are reported separately.

Of the different branches of the industry represented in the State, the granite trade showed a slight improvement, increasing from $148,633 in 1911 to $202,086 last year. The yield, however, was below the average of earlier years.

The limestone quarries contributed more than one-half of the total for the year, with a product valued at $3,510,495. The figures for 1911 were $3,174,161. The use of limestone for crushed stone accounts for its predominant importance, though it is also largely employed for lime making, furnace flux, and for building stone.

There was a slight falling off in the value of the marble quarried which amounted to $241,847, against $278,041 in the preceding year. The decrease was in the building stone supplied by the southeastern New York quarries.

The sandstone quarries contributed an output valued at $1,280,743 against $1,060,106 in 1911. The increase of about 20 per cent did not restore the industry to the high level reached a few years ago, but indicated a temporary check at least to the decline that has recently taken place, incident to the unsatisfactory conditions of the flagstone trade.

The trap quarries in the Palisades section reported an output scarcely more than one-half that of previous years, in actual figures, $483,863 as compared with $899,414 in 1911. The decrease has been due to the shutting down of some of the river quarries by their inclusion in the new Palisades Park.

Production of stone in 1910

VARIETY	BUILDING STONE	MONUMENTAL	CURBING AND FLAGGING	CRUSHED STONE	ALL OTHER	TOTAL VALUE
Granite	$40 911	$12 989	*a*	$91 988	$98 875	$244 763
Limestone	99 049	.....	$3 888	1 815 809	1 327 061	3 245 807
Marble	252 965	88 684	.....	.....	231	341 880
Sandstone	387 408	.....	480 132	225 408	358 848	1 451 796
Trap	.....	.....	.....	908 931	75	909 006
Total	$780 333	$101 673	$484 020	$3 042 136	$1 785 090	$6 193 252

a Included under "All other."

Production of stone in 1911

VARIETY	BUILDING STONE	MONUMENTAL	CURBING AND FLAGGING	CRUSHED STONE	ALL OTHER	TOTAL VALUE
Granite	$30 684	$11 353	*a*	$72 401	$34 195	$148 633
Limestone	112 082	.....	$11 989	1 936 292	1 113 798	3 174 161
Marble	171 748	79 115	.....	.....	27 178	278 041
Sandstone	327 587	.....	526 074	23 883	182 562	1 060 106
Trap	.....	.....	.....	896 164	3 250	899 414
Total	$642 101	$90 468	$538 063	$2 928 740	$1 360 983	$5 560 355

a Included under "All other."

Production of stone in 1912

VARIETY	BUILDING STONE	MONUMENTAL	CURBING AND FLAGGING	CRUSHED STONE	ALL OTHER	TOTAL VALUE
Granite	$65 487	$19 130	*a*	$49 307	$68 172	$202 096
Limestone	108 581	.....	$5 481	2 176 368	1 220 015	3 510 445
Marble	155 411	84 511	.....	.....	1 925	241 847
Sandstone	363 055	.....	615 846	45 301	256 541	1 280 743
Trap	.....	.....	.....	483 863	.....	483 863
Total	$692 534	$103 641	$621 327	$2 754 839	$1 546 653	$5 718 994

a Included under "All other."

GRANITE

Granite, in the strict sense, includes the coarser-grained igneous rocks which have quartz, feldspar and mica as their chief constituents. They are characterized by a massive appearance incidental to an even distribution of the mineral ingredients, though by compression during or after the period of consolidation they may develop a parallel arrangement, in which case the term granite gneiss is best applied to them. The feldspar of typical granite is an alkali variety, either orthoclase or microline, but some lime-soda-feldspar like oligiclase is usually present as well. Hornblende and more rarely augite may accompany the mica or substitute for it. The texture is even granular or porphyritic.

The definition as given is rather narrow for commercial usage

and quarrymen often designate as granite widely different rocks which may serve more or less similar purposes. Thus in the Adirondacks not only granite, but syenite, anorthosite and various gneisses have been quarried and sold as granite. The broader usage will be followed here, so as to include practically all the crystalline silicate rocks, with the exception of trap which, owing to its somewhat specialized industrial features, will be treated by itself.

Granites and their igneous associates have a wide distribution in the Adirondacks and are represented rather extensively in the Highlands and in Westchester county. Some account of their distribution and present development for commercial use will be found in the preceding issue of this report. It may be said that the quarry industry in most localities is in a backward condition, neither commensurate with the resources which are sufficiently varied to meet most requirements for structural and ornamental granite, nor with the large local markets which exceed those of any state in importance. As a consequence, most of the building, monumental and ornamental granite for current use comes from the larger and better equipped quarries in New England and the southern states.

The production of granite for the last three years is shown in the accompanying table. The figures are compiled from reports of quarries operated for commercial purposes, but do not include the output by contractors on road improvement work, as such production is difficult to tabulate. The output in 1912 had a value of $202,096, against $148,633 in the preceding year and $244,763 in 1910. The largest item in the total was represented by building stone with a value of $65,487, followed by crushed stone valued at $49,307, rubble and riprap valued at $27,861 and monumental stone valued at $19,130. The granite sold for various other purposes was valued at $40,311.

Production of granite

	1910	1911	1912
Building	$40 911	$30 684	$65 487
Monumental	12 989	11 353	19 130
Crushed stone	91 988	72 401	49 307
Rubble, riprap	20 272	28 162	27 861
Other kinds	78 603	6 033	40 311
	$244 763	$148 633	$202 096

NOTES ON GRANITE QUARRYING IN NEW YORK

Peekskill. The Mohegan Granite Co., owning quarries east of Peekskill, supplied a large part of the architectural granite produced in the last year, shipping most of the output to New York for use in the Episcopal Cathedral. The company is enlarging its facilities for handling this material which has obtained much favor among architects and builders on account of its rare and attractive color. At present it has three derricks in the main quarry, which is an opening 300 feet long with a face from 40 to 50 feet high. Except for large inclusions of hornblende schist which occur here and there, the granite is free of knots and streaks. It has a slight tendency to sheeting and is intersected by two sets of vertical joints which occur at such intervals as to admit the extraction of blocks as large as can be handled. The company has recently erected a steel-frame cutting shed at the quarries, which will afford room for 40 or 50 cutters.

The yellow and brownish varieties which have been mainly quarried are developed in the upper surficial part of the granite boss, as a result of the seepage of iron oxid into the minute cracks and pore spaces of the stone. The iron is principally concentrated about the quartz grains. It seems to have been derived from alteration of the biotite in the overlying portion which has since been eroded away, as the quarried stone appears quite fresh when examined microscopically. The granite is rather porous, but in crushing strength compares favorably with other granites.

The normal or original color of the Peekskill granite is light gray, or pinkish gray, as seen in the quarries of Rudiger Bros. on Millstone hill, across the valley from the Mohegan Company's quarries and in a smaller quarry near Peekskill. The change from gray to brown takes place at a variable depth, usually 40 or 50 feet from the surface.

Kensico. Quarries have been opened in the last year at Kensico for the construction of the new reservoir which is to form a part of the Catskill water-supply system. The quarries are situated on the ridge that limits the reservoir on the east, about three-fourths of a mile from the dam location with which they are connected by a railway. The rock is Yonkers gneiss of medium grayish or brownish gray color and more massive texture than the usual average of the rock. The grain is medium or fine. Several acres have been cleared of overlying earth and soil, showing fairly uniform and

fresh material at the surface. There are scattered inclusions of dark hornblende and biotite gneiss, probably the Fordham, but with this exception it is quite free of admixture and well adapted for building and general construction purposes. Its composition is that of a normal biotite granite. The gneissoid character is partly at least original, rather than assumed after the crystallization, and the texture is firmly knit like that of a massive rock. The effects of shearing and compression are observable, however, in restricted areas. The granite is quarried by drilling and blasting. The heavier blocks are used for cyclopean masonry, and the smaller material goes to the crushing plant, which is a large concrete and steel structure.

Mamaroneck. Quarry operations are conducted by Faillace Brothers in an exposure of grano-diorite in the town of Mamaroneck, a little west of the village of that name. The rock belongs to the large intrusion which extends northeasterly across Rye and Harrison townships into Connecticut where it is known as the Danbury grano-diorite. It is medium to dark in color, with abundant biotite which by its linear arrangement lends a gneissoid appearance to the mass. It has a fine grain, varied at times by porphyritic feldspars which measure up to an inch in length. The porphyritic phase resembles very much the augen-gneiss at Bedford in northern Westchester county.

The Faillace quarry consists of an opening along a northeast-southwest ridge, 200 feet in length and 30 to 50 feet in height. The grano-diorite is here rather dark, rich in biotite, and carries considerable garnet. It shows traces of sheet structure as exposed in the quarry, the sheets being from 6 to 8 feet thick and dipping slightly southward. The principal set of joints strikes northeasterly parallel to the foliation and dips 75° or so northwest. Another system crosses this at a high angle but is irregular and at times obscure. The rock is quite uniform in appearance, being fairly free of knots and streaks and pegmatitic injections. The color effect of the cut stone varies somewhat on the different sides. Parallel to the foliation the biotite is more in evidence than the feldspar and lends a very dark, almost black, color to that side. Across the foliation, the color is grayish, mottled by the white feldspar augen, which are more prominent in the horizontal plane. For building purposes, it is cut so as to present the lighter color, across the foliation.

In composition, the rock from this quarry is intermediate between granite and diorite. The feldspar in the ground mass is mainly plagioclase either oligoclase or andesine, while the porphyritic individuals which are clear and glassy have the characters of microcline. Quartz is fairly abundant and of smoky color. The reddish garnet occurs in scattered grains and large aggregates of grains, apparently a secondary development from the feldspar and biotite. A green hornblende occurs in small amount. The rock shows little weathering, except in the clouding of the plagioclase feldspar, and is a strong, tough building material.

The product of the quarries is mainly building stone which is cut and dressed by bush hammering at the quarries. The waste is used for riprap and crushed stone, a small crusher being set up on the property. Shipment is made by Mamaroneck station on the New Haven Railroad one-half mile distant from the quarries.

Campbell's quarry at Larchmont, which was described by Eckel in his paper "The Quarry Industry in Southeastern New York," has not been worked for a number of years and probably will not again be operated, as the vicinity is being rapidly developed for residence purposes. The grano-diorite is not so even in texture and rather more affected by weathering than at the other quarry localities.

A quarry has been opened along the ridge northeast of Campbell's quarry and one-quarter mile west of the New Haven Railroad. It has been idle during the last two or three years, but the waste is used in a crusher nearby. It has a face about 125 feet long on the strike of the grano-diorite gneiss and from 20 to 35 feet high. The rock contains more biotite and is therefore darker in color than that at the other quarries in this vicinity, while the foliation is more marked, resembling the structure of a typical gneiss. A few small bands and lenses of pegmatite afford the only noteworthy variation in the exposure. The strike of the foliation is northeast and the dip northwest at an angle of 75°. Two systems of nearly vertical joints run northeast and northwest respectively, besides which there is a fairly well-marked sheeting which dips 10° or so south. The joints divide the mass into cubical blocks that average 6 or 7 feet in each dimension. The product has been mainly used for building and other large structures. There is no equipment on the property at present.

LIMESTONE

The stone classified under the heading of limestone consists for the most part of the common grades of limestone and dolomite such as are characterized by a compact granular or finely crystalline texture and are lacking in ornamental qualities.

A smaller part is represented by crystalline limestone and by the waste products of marble quarrying which is sometimes employed for crushed stone, lime making or flux. Limestone used for the manufacture of portland and natural cement is, however, excluded from the tabulations so as to avoid any duplications of the statistics.

Limestones have a wide distribution in the State, the only region which is not well supplied being the southern part where the prevailing formations are sandstones of Devonic age. The monocrystalline varieties occur in regular stratified order in the Cambric, Lower Siluric, Upper Siluric and Devonic systems. In most sections they occupy considerable belts and have been little disturbed from their original horizontal position. On the borders of the Adirondacks and in the metamorphosed Hudson River region, however, they have been more or less broken up by faulting and erosion and in places have a very patchy distribution.

The Cambric limestones are found in isolated areas on the east, south and west sides of the Adirondacks. They are usually impure, representing a transition phase between the Potsdam sandstones below and the high calcium limestones above. The lower beds of the Beekmantown formation as originally defined are now known to belong to the Cambric system. The Little Falls dolomite is perhaps the most prominent member of the Cambric limestones and is extensively developed in the Mohawk valley with quarries at Little Falls, Amsterdam, and other places. It is a rather heavily bedded stone of grayish color, suitable more especially for building purposes. In Saratoga county the Hoyt limestone is in part the equivalent of the Little Falls dolomite; it has been quarried for building stone just west of Saratoga Springs. On the west side of the Adirondacks the Theresa limestone is described by Cushing as a sandy dolomite which may in part belong to the Cambric system. It is comparatively thin and has no importance for quarry purposes.

The Beekmantown limestone, which is now taken as including the middle and upper beds of that series as earlier defined, is mostly restricted to the Champlain valley. It occurs on the New York shore in rather small areas, usually down-faulted blocks, that are the remnants of a once continuous belt. It is also represented

doubtless in the basal portion of the limestone area that extends across Washington and Warren counties. The only place where it has been extensively quarried is at Port Henry where the purer layers have been worked for flux. In the Lake Champlain region it is a bluish or grayish magnesian limestone occurring in layers from a few inches to several feet thick.

The Chazy limestone is found in the same region as the Beekmantown in discontinuous areas along the eastern Adirondacks from Saratoga county north to the Canadian boundary. It attains its maximum thickness in eastern and northeastern Clinton county, and has been quarried around Plattsburg, Chazy and on Valcour island. The Chazy is the earliest representative of the Paleozoic formations characterized by a fairly uniform high calcium content; it analyzes 95 per cent or more of calcium carbonate. It has a grayish color and finely crystalline texture. The fossiliferous beds afford attractive polished material which is sold as "Lepanto" marble. It is used also for lime and furnace flux. There are old quarries on Willsboro point, Essex county. On the west side of the Adirondacks the Pamelia limestone described in the areal reports of that section, belong to the Chazy series. It covers a considerable area in Jefferson county between Leraysville and Clayton, and has been rather extensively quarried for building stone and lime, though of subordinate importance to the Trenton limestones of that section.

In the Mohawkian or Trenton group are included the Lowville (Birdseye), Black River and Trenton limestones which have a wide distribution and collectively rank among the very important quarry materials of the State. They are represented in the Champlain valley but are specially prominent on the Vermont side; from the latter area a belt extends southwest across northern Washington county to Glens Falls in Warren county and is continued into Saratoga county. Another belt begins in the Mohawk valley near Little Falls and extends northwesterly with gradually increasing width across Oneida, Lewis and Jefferson counties to the St Lawrence river. There are isolated areas of Trenton limestones in the Hudson valley south of Albany. The limestones vary in composition and physical character according to locality and geologic position. They are often highly fossiliferous. In the northern section they are mostly gray to nearly black in color, contain little magnesia and run as high as 97 or 98 per cent calcium carbonate. The lower part of the group is heavy bedded and well adapted for build-

ing stone; the upper beds commonly contain more or less shale. They are used for various purposes including building and ornamental stone, crushed stone, lime, portland cement and flux. In the Champlain valley quarries are found near Plattsburg, Larabees Point and Crown Point; in Washington county at Smiths Basin; in Warren county at Glens Falls where there are extensive quarries that supply material for building purposes, portland cement and lime. The well-known black marble from Glens Falls is taken from the Trenton. Numerous quarries have been opened in Herkimer, Oneida, Lewis and Jefferson counties. The output of the last named county is specially important, including limestone for building and road construction and lime for manufacture of calcium carbide. The principal quarries in Jefferson county are at Chaumont.

The next assemblage of limestones in the order of stratigraphic occurrence includes the Clinton, Lockport and Guelph members of the Niagara group. The Clinton limestone has a variable importance in the belt of Clinton strata that extends from Otsego county a little south of the Mohawk river across the central and western parts of the State on the line of Oneida lake and Rochester to the Niagara river. East of Rochester the limestone is relatively thin, usually shaly and split up into several layers, but on the west end in Niagara county it becomes the predominant member and has a more uniform character. Large quarries have been opened recently at Pekin, Niagara county, for the supply of flux to the blast furnaces of the Lackawanna Steel Co. at Buffalo. The upper beds of bluish gray fossiliferous limestone from 10 to 12 feet thick are the purest and analyze from 90 to 95 per cent calcium carbonate. The Lockport is a magnesian limestone, in places a typical dolomite, and is rather siliceous in the lower part. It outcrops in a continuous belt, several miles wide, from Niagara Falls east to Onondaga county and then with diminishing width across Madison county. The upper layers are rather heavy and yield material suitable for building purposes, road metal and lime. There are quarries around Niagara Falls, Lockport and Rochester. It is worked to some extent in Wayne, Onondaga and Madison counties. The Guelph, also a dolomite, occupies a limited area in Monroe and Orleans counties and is worked near Rochester.

The Cayugan group includes among its members the Cobleskill, Rondout and Manlius limestones, which are economically important. They have furnished large quantities of material for the manu-

facture of natural cement, being the source of the cement rock in the Rosendale district and in Schoharie and Onondaga counties. The cement rock of Erie county is found in the Salina formation. The purer layers are employed in Onondaga county for lime-making. The Manlius limestone is used for portland cement in the eastern part of the State.

At the base of the Devonic system appears the Helderbergian group which is very prominent for its calcareous strata. Limestones of this age are strongly developed along the Hudson river in Albany, Columbia, Greene and Ulster counties. The Coeymans or lower Pentamerus and the Becraft or upper Pentamerus limestones afford material for building, road metal, lime and portland cement. The limestone for the portland cement works at Hudson and Greenport is obtained from Becraft mountain, an isolated area of limestones belonging to the Manlius, Helderbergian and Onondaga formations. The works at Howes Cave use both the Manlius and Coeymans limestones. Extensive quarries are located also at Catskill, Rondout and South Bethlehem.

The Onondaga limestone, separated from the preceding by the Oriskany sandstone, has a very wide distribution, outcropping almost continuously from Buffalo, Erie county, eastward to Oneida county and then southeasterly into Albany county, where the belt curves to the south and continues through Greene, Ulster and Orange counties to the Delaware river. It is in most places a bluish gray, massive limestone with layers and disseminated nodules of chert. The chert is usually more abundant in the upper beds. The limestone finds use as building stone and the less siliceous material, also, for lime-making. Quarries have been opened at Kingston, Split Rock (near Syracuse), Auburn, Waterloo, Seneca Falls, Leroy, Buffalo and other places.

The Tully is the uppermost of the important limestone formations and likewise the most southerly one represented in the central part of the State. Its line of outcrop extends from Ontario to Madison county, intersecting most of the Finger Lakes. Its thickness is not over ten feet, and on that account can not be worked to advantage except under most favorable conditions of exposure. For building stone it is quarried only locally and to a very limited extent. It finds its principal use in portland cement manufacture, being employed for that purpose by the Cayuga Lake Cement Co. in its works at Portland Point, Tompkins county.

Marl is a useful substitute for the hard limestones for some purposes and is rather extensively developed in the central and western parts of the State. It is found particularly in swampy tracts and old lake basins associated with clay and peat. In the Cowaselon swamp near Canastota the marl underlies several thousand acres and is said to be 30 feet thick. The Montezuma marshes in Cayuga and Seneca counties contain a large deposit which at Montezuma is 14 feet thick. In Steuben county the marls at Arkport and Dansville have been employed for lime-making. Until recently marls have been used extensively for portland cement and plants were operated at one time in the marl beds near Warner and Jordan, Onondaga county; at Montezuma, Cayuga county; Wayland, Steuben county; and Caledonia, Livingston county. Their principal use at present is for agricultural and chemical purposes.

Production of limestone. The limestone quarried for various uses constitutes more than one-half the total value of the quarry products of the State. The proportion would be even more in favor of limestone if the stone consumed in portland cement manufacture was reckoned in the total, but that is excluded in order to avoid duplication of the statistics.

The reports submitted by the quarry companies indicate a very large increase in the output for 1912, the total value of which amounted to $3,510,445 against a value of $3,174,161 in 1911. The advance raised the figures above those for any previous year; the next highest total was $3,300,383 in 1909. As in other branches of the industry, no account has been made of the stone quarried by contractors in connection with road improvement work, for which it is impossible to secure reliable data.

Production of limestone

MATERIAL	1910	1911	1912
Crushed stone	$1 815 809	$1 936 292	$2 176 368
Lime made	365 839	400 396	452 002
Building stone	99 049	112 082	108 581
Furnace flux	538 491	454 800	542 154
Rubble, riprap	30 819	20 328	10 696
Flagging, curbing	3 888	11 989	5 481
Miscellaneous	391 912	238 274	215 163
Total	$3 245 807	$3 174 161	$3 510 445

Erie county outranks all others in importance in this industry; its products are chiefly furnace flux, crushed stone and building stone. The value of the limestone quarried within the county last year was $923,847. The larger quarries are at North Buffalo, Clarence and Akron.

Onondaga county occupies second place, the result mainly of the operations of the Solvay Process Co., with its quarries at Jamesville which are among the largest and best equipped of any in the country. Besides the stone used by the company in the alkali works at Syracuse, it sells a large quantity for road making, cement and other purposes. The Lackawanna Stone Co. has quarries under development which will probably enter upon active production during the current year.

The other counties reporting a value of over $100,000 in 1912 were Dutchess, Rockland, Ulster, Genesee, Warren, Niagara, Albany and Schoharie, ranking in the order named. A large quarry to furnish flux is being opened near Gasport, Niagara county. This locality lies on the outcrop of the Clinton formation, the same as the flux quarry near Pekin, a little farther west. The quarry is to be operated by the Wickwire Limestone Co. It is reported that a limestone quarry is under development at Oriskany Falls, by Bardorf, Davis & Chapman.

The distribution of the limestone according to counties and also according to uses is shown in the accompanying tables for the years 1911 and 1912.

Crushed stone. Limestone finds its principal application as crushed stone in which form it is employed for road metal, concrete and railroad ballast. There are large quarries supplying crushed stone in Erie, Genesee, Dutchess, Ulster and Rockland counties, as well as many smaller quarries in other counties. The canal, highway and other public improvements in current progress have created large markets for the material and the production has shown a steady increase. A considerable quantity of the fines made by the crushing plants is sold for agricultural purposes as a substitute for burnt rock or lime.

The value of the crushed limestone for 1912 reached a total of $2,176,368 against $1,936,292 for the preceding year. As stated already, the total does not include the stone crushed by contractors for local use on the highway system. The actual quantity turned out by the crushing plants was 3,559,257 cubic yards, as compared with 3,116,958 cubic yards in 1911. Erie county alone made an out-

put of 958,763 cubic yards valued at $607,107. The other leading counties were Dutchess, Rockland, Ulster, Onondaga, Genesee and Albany.

Lime. The value of lime made for market last year was $452,002 as compared with $400,396 in 1911. In quantity, it amounted to 93,176 short tons. In addition there was a large output made in connection with chemical manufactures, such as alkali, carbide etc., which, as it was not sold as such, has been included under "other uses." The principal quarries for lime manufacture are in Warren, Clinton, Washington, Lewis and Jefferson counties.

Building stone. The limestones found in the State have a limited sale for building purposes, and few quarries supply more than a local demand, so that their output fluctuates greatly from year to year. The restricted market seems to be due to the fact that the limestones are prevailingly of grayish color in medium to dark tints, whereas the present demand is for white or very light gray stone such as the Bedford stone. The extending use of concrete has also been a factor in the recent decline of the cut-stone trade, though it has increased the sale of crushed stone.

The total product of building stone, according to the returns for 1912, had a value of $108,581. This was a little larger than the value for 1911 which amounted to $99,049, but considerably less than the totals reported in some of the earlier years. Erie county as usual was first in this branch of the trade; its output was valued at $67,912. Cayuga, Onondaga, Montgomery, Warren and St Lawrence counties contributed smaller amounts.

Furnace flux. The output of stone for use in blast furnaces, foundry furnaces and other metallurgical operations has assumed large proportions. For such purposes, a relatively pure material is desired, though the presence of magnesia may not be detrimental to some applications as in iron smelting. The principal quarries of flux are in the Onondaga limestone of Erie and Genesee counties and the Clinton limestones of Niagara county. Smaller amounts of flux are obtained from the Precambric crystalline limestones in St Lawrence and Essex counties, the Chazy limestone in Clinton county, and other formations.

The production of flux in 1912 was valued at $542,154, representing a total of 1,032,481 tons. The corresponding figures for the preceding year were $454,800 and in quantity 792,248 tons. Niagara county had the largest production, with Erie in second place.

Production of limestone by counties in 1911

COUNTY	CRUSHED STONE	LIME MADE	FURNACE FLUX	BUILDING STONE	OTHER USES	TOTAL
Albany	$132 925	.....	.....	.....	.....	$132 925
Cayuga	28 494	.....	.....	$12 100	.....	40 594
Clinton	12 192	$62 002	$9 511	625	$579	84 909
Erie	489 881	300	268 082	77 689	7 663	843 615
Genesee	204 896	.....	.....	.....	.....	204 896
Greene	2 625	.....	2 000	.....	.....	4 625
Herkimer	9 283	2 603	.....	.....	.....	11 886
Jefferson	16 749	*a* 18 625	.....	.....	40 220	75 594
Lewis	2 850	35 000	.....	95	91	38 036
Madison	34 361	22 625	5 000	100	.....	62 086
Monroe	16 133	18 780	.....	3 291	994	39 198
Montgomery	39 000	.....	.....	5 338	11 184	55 522
Niagara	.....	525	141 824	800	.....	143 149
Onondaga	170 402	*a* 53	.....	10 178	190 704	371 337
Rensselaer	16 556	.....	100	.....	1 268	17 924
St Lawrence	287	6 824	24 186	652	13	31 962
Saratoga	3 792	.....	.....	.....	.....	3 792
Schoharie	19 640	300	.....	457	4 600	24 997
Seneca	5 650	22	61	487	74	6 294
Ulster	167 472	19 300	.....	.....	.....	186 772
Warren	18 161	165 064	.....	270	5 621	189 116
Washington	1 000	10 000	.....	.....	.....	11 000
Westchester	.....	21 072	253	.....	4 027	25 352
Other counties *b*	543 943	17 301	3 783	.....	3 553	568 580
Total	$1 936 292	$400 396	$454 800	$112 082	$270 591	$3 174 161

a Lime made by Solvay Process Co. and Union Carbide Co. included in "Other uses."
b Includes Columbia, Dutchess, Essex, Fulton, Oneida, Ontario, Orange and Rockland counties.

Production of limestone by counties in 1912

COUNTY	CRUSHED STONE	LIME MADE	FURNACE FLUX	BUILDING STONE	OTHER USES	TOTAL
Albany	$136 690	.....	.....	.....	.....	$136 690
Cayuga	32 620	.....	.....	$7 330	.....	39 950
Clinton	8 694	$60 521	$13 423	600	$2 881	86 119
Erie	607 107	75	246 091	67 912	2 662	923 847
Genesee	214 310	6 750	54 557	.....	6 000	281 617
Greene	3 250	.....	6 000	.....	.....	9 250
Herkimer	14 826	.....	.....	.....	.....	14 826
Jefferson	18 865	*a* 17 942	.....	.....	.....	36 807
Lewis	1 568	35 000	.....	39	2 782	39 389
Madison	33 957	.....	.....	766	.....	34 723
Monroe	28 079	6 600	.....	2 307	.....	36 986
Montgomery	17 794	.....	.....	7 259	1 886	26 939
Niagara	.....	.....	192 915	1 407	2 800	197 122
Oneida	51 507	14 280	.....	.....	.....	65 787
Onondaga	204 998	*a*	.....	6 407	208 914	420 319
Rensselaer	23 974	.....	.....	150	.....	24 124
St Lawrence	1 035	5 277	24 612	5 149	.....	36 073
Schoharie	96 000	.....	210	2 089	1 658	99 957
Ulster	38 375	16 360	.....	.....	.....	54 735
Warren	46 434	207 727	.....	6 441	308	260 910
Washington	.....	43 350	.....	300	.....	43 650
Westchester	.....	11 695	100	.....	1 000	12 795
Other counties *b*	596 285	26 425	4 246	425	449	627 830
Total	$2 176 368	$452 002	$542 154	$108 581	$231 340	$3 510 445

a Lime made by Solvay Process Co. and Union Carbide Co. included in "Other uses."
b Includes Columbia, Dutchess, Essex, Fulton, Ontario, Orange, Rockland and Seneca counties

MARBLE

Marble, in the commercial sense, like granite, includes a variety of rocks that lend themselves to building or decorative uses. Most commonly, the name signifies a crystalline aggregate of calcite or dolomite, as distinguished from ordinary limestones which at best are of indistinctly crystalline nature. At the same time it implies the feature of attractiveness by reason of color and the ability to take a lustrous polish. Rocks possessing all these features are marbles in the strict sense to which the name may be applied without qualification. Some compact or granular limestones that lack the elements of thorough crystallinity make, however, a handsome appearance when polished, and such are commercially classed as marbles. Fossil marbles, black marbles, and a few other kinds are commonly of the noncrystalline type. Serpentine marble, or verde antique, is made up for the most part of the mineral serpentine,

a silicate of magnesium and iron, and is therefore not related to the varieties already described. Ophitic limestone, or ophicalcite, is a crystalline limestone or dolomite carrying grains and nodules of serpentine scattered more or less evenly through its mass. Its ornamental quality lies in the speckled or mottled pattern and the sharp contrast between the clear white ground mass and the greenish serpentine inclusions.

Marbles belonging to these various types find representation in the geologic formations of the State and are quarried on a commercial scale or have been so quarried in the past.

The true or crystalline varieties are limited in occurrence to the metamorphic areas of the Adirondacks and southeastern New York. They are of early geologic age, antedating the period of crustal disturbance and metamorphism which in the Adirondacks was brought to a close practically long before Cambric time and which in southeastern New York was completed in the Paleozoic. This thoroughly crystalline character is in fact a development of the strong compression accompanied by heat to which they have been subjected; having been originally, no doubt, ordinary granular or fossiliferous limestones similar to those so plentifully represented in the undisturbed formations outside the regions.

The crystalline limestones of the Adirondacks are most abundant on the western border in Jefferson, Lewis and St Lawrence counties where they occur in belts up to 4 or 5 miles wide and several times as long, interfolded and more or less intermixed with sedimentary gneisses, schists and quartzites. They are found in smaller and more irregularly banded areas in Warren and Essex counties on the eastern side, but have little importance elsewhere. The ophitic limestones that have been quarried at different times belong to the same series. The marbles of the Adirondacks comprise both the calcite class with very little magnesia and the dolomite class containing high percentages of magnesia. No definite relation is apparent in regard to the occurrence of the two and both may be found in the same area and in close association.

The southeastern New York marbles occur in belts which follow the north-south valleys, east of the Hudson, from Manhattan island into Westchester, Dutchess and Columbia counties. They range from very coarsely crystalline to finely crystalline rocks, are prevailingly white in color and belong to the dolomite class. They are interfolded with schists and quartzites, the whole series having steep dips like those of strongly compressed strata. The geologic age

of the southern belts is probably Precambric, but on the north and east within range of the Taconic disturbance, they may belong to the early Paleozoic.

Bodies of practically pure serpentine of considerable extent are found on Staten Island and in Westchester county near Rye; they represent intrusions of basic igneous rocks whose minerals, chiefly pyroxene and olivine, have subsequently changed to serpentine. They are not important for quarry purposes, owing to the frequency of fissures and joints and the rather somber color of the exposed parts of the masses.

The microcrystalline or subcrystalline limestones that are sometimes sold as marbles include members of the regularly bedded unmetamorphosed Paleozoic limestones, which locally, show qualities of color and polish that make them desirable for decorative purposes. They range from dense granular varieties to those having a more or less well developed crystalline texture and are often fossiliferous. Inasmuch as they have never been subjected to regional compression or been buried in the earth deep enough to become heated, the crystalline texture, when present, may be ascribed to the work of ground waters. These circulate through the mass, taking the carbonates of lime and magnesia into solution, and redeposit them in crystalline form. Originally, the limestones were accumulations of lime-secreting fossils or granular precipitates, for the most part of marine origin. Some of the localities where these unmetamorphic marbles occur are on the west shore of Lake Champlain, around Plattsburg and Chazy (Chazy limestone), Glens Falls (Trenton limestone) and Becraft mountain and Catskill (Becraft limestone).

Production. The number of active quarries in the State is small and the annual output falls below that of other quarry materials, with the single exception of granite. There is considerable fluctuation, however, in the output, depending chiefly upon the activity in building operations, as the greater part of the product is sold as architectural stone. A single contract for a large structure may make a very apparent difference in the annual total.

In 1912, there were seven active quarries, with a product valued altogether at $241,847. Nearly one-half of the value, or $114,466, was reported by three quarries in the Gouverneur district. Two quarries in southeastern New York, with one at Plattsburg and one at Glens Falls, contributed the remainder. The figures for the last three years are shown in the accompanying table.

Production of marble

VARIETY	1910	1911	1912
Building marble	$252 965	$171 748	$155 411
Monumental	88 684	79 115	84 511
Other kinds	231	27 178	1 925
Total	$341 880	$278 041	$241 847

NOTES ON NEW YORK MARBLE QUARRIES

The marble resources of the State have been described only in a very general way, and the published information is mainly contained in the reports of the Tenth Census and Smock's bulletin on "Building Stone in New York" which reflect conditions as they existed twenty-five years or more ago. The following account of some of the developed quarries has been prepared from observations made in the summer of 1912, intended as a basis for a detailed geological, petrographical and chemical study of the subject.

Gouverneur district. The principal area of crystalline limestones with their interbedded gneisses, schists and quartzites, which together represent the Grenville series of the Adirondack region, is exposed in southwestern St Lawrence county and the contiguous part of Jefferson county in the interval between the Adirondack highland and the St Lawrence river. The area is irregular in outline, but is drawn out along a northeast-southwest direction which is the main structural trend of the region. The northeastern section in Canton and DeKalb townships, St Lawrence county, consists of a narrow belt a mile or so wide, but as it continues southwesterly into Gouverneur, it expands so as to cover most of that town and the adjoining towns of Macomb and Rossie on the north and west, narrowing at the county line and soon terminating in the towns of Antwerp and Theresa, Jefferson county. The total surface covered by this body of Grenville strata may be placed at approximately 175 square miles.

Throughout the area, the limestone is the most persistent and conspicuous member of the series, but it gives way locally to micaceous, pyritic schists, graphitic or glassy quartzites and dark hornblende gneisses and amphibolites. The several formations have the appearance of an interbedded but strongly folded, compressed and altered series of sediments. Subsequent to their folding and meta-

morphism, they have been subjected to profound erosion so that the present surface represents what once was the deeply buried portion of the strata. As a result of these vicissitudes there is little evidence remaining of the precise structural relations presented by the complex or of the order in which the various members were originally deposited.

Intrusions of deep-seated rocks, mainly granitic in character, occur within the area. They have a more or less gneissoid appearance but not the schistosity of the Grenville gneisses, are prevailingly reddish or gray in color and belong mostly to the biotite and hornblende varieties of granite. They form bosses of some size and also sills and dikes. In their vicinity the schists and gneisses are injected by small offshoots of the granites and their pegmatites which oftentimes assume the appearance of a perfect maze of interlacing veins so that the rock is as much igneous as sedimentary in character. Besides these clearly intrusive granites and granite gneisses, there are frequent bodies of gneiss in the forms of bands and lenses which stand in indefinite relationship to the Grenville and which, like some of the gneisses on the border of the area, must await more detailed study and mapping before they can be definitely classified.

The crystalline limestone of this area constitutes one of the larger bodies of high-grade calcium limestones found in the State. It is mainly an aggregate of coarse granular calcite, white in color, holding a few included minerals like phlogopite, graphite and pyrite in scattered crystals. The average content in carbonates exceeds 90 per cent. Though it is called a calcium limestone, there is always a small amount of magnesia present — from 1 to 3 per cent — and in places it has the character of a dolomite. The change to dolomite takes place rather abruptly but apparently without reference to structural lines that might suggest original variations of deposition. The occurrence of dolomite is, however, quite local and unimportant as compared with the great body of limestone. On the other hand, the limestone shows well-marked zones or bands in which quartz and silicates are abundant and which seem to be the result of impurities included when it was being laid down. A peculiar type is represented by an admixture of white quartz and calcite in nearly equal proportions, the two minerals occurring in alternating seams, lending the appearance of a schistose rock, or else in grains and masses thoroughly intermingled. Contact effects with the intrusive granites are manifested in the development of silicate minerals like tourmaline, vesuvianite, pyroxene, tremolite

etc., which in restricted areas become very abundant. Of valuable minerals, hematite and pyrite occur in commercial quantity, while galena, sphalerite, fluorite and barite are found in smaller bodies.

The following analyses of the limestones are based on samples from the different marble quarries, but may be said to represent the general character of the rock when fairly free of admixture. Nos. 1, 2 and 3 are by R. W. Jones, made on samples collected by the writer in 1912. No. 1 is based on sample from the extra-dark quarry of the St Lawrence Marble Quarries; no. 2, quarry of Gouverneur Marble Co; no. 3, Rylestone quarry. No. 4 is an analysis of the marble in Northern New York quarry made some years ago but not hitherto published. No. 5 represents the dolomitic marble, formerly worked by the White Crystal Marble Co.; analysis made at Watertown arsenal.

	1	2	3	4	5
Insol	3.55	1.26	1.01	.....	.....
SiO_2	.....	.....	.....	1.58	.28
Al_2O_3	.13	.65	.23	.79	.10
Fe_2O_3	.08	.29	.63		
MgO	.....	.....	.....	3.49	20.64
$MgCO_3$	6.40	7.50	6.85	7.33	.....
CaO	.....	.....	.....	51.45	31.45
$CaCO_3$	87.06	87.47	88.94	91.88	.....
H_2O	1.68	1.46	1.74	.....	.....
CO_2	.....	.....	.....	42.56	47.38
S	.05	.02	.04	.03	.06

The typical Gouverneur marbles as illustrated in the first four analyses show a very uniform composition in respect to the lime and magnesia. On the other hand, the white marble shows a much larger amount of magnesia which reaches the proportions of a dolomite.

The Gouverneur marble all comes from a small area southwest of that town; the quarries, with one or two exceptions, lie along a narrow belt which extends for a little over a mile in a northeast and southwest direction. The greater number of openings are on the eastern section. The quarries lie on the outcrop of the marble "vein" or beds which dip northwest at an angle ranging from 15° to 30° on the eastern end to 80° or 90° on the western end. Besides the dip, there is a well-marked pitch that seems to be mainly southwest at an angle of 20° or 25°. The structure resembles that of an overturned pitching fold which has undergone deep erosion.

In color and texture, the marble shows variety, though the differences are not specially prominent between the several merchantable grades of stone. It is mottled white and grayish blue, or light and

dark blue, running in places to almost dark blue which is the color most sought for. In the lighter mottled sorts, the grain is coarse and somewhat irregular, with the light and darker calcite segregated more or less into separate areas. The individual calcite grains mostly have a diameter of about 1 or 2 mm. In the dark blue marble, however, the grain is much finer, the calcite averaging only a fraction of a millimeter in diameter. The variation in color seems to be traceable to the presence of graphitic carbon which is scattered irregularly through the mass in submicroscopic particles. The presence of carbon was indicated in the chemical analysis, but no determination of it was made, the actual amount being extremely small.

The marble is susceptible of high polish and has a luster very much like that of some gray granites. It is well adapted for monumental work and the better grades are mainly used for that purpose. Its weathering qualities are attested by nearly a century of use as monumental and building stone. For building purposes it has found considerable sale in the large towns and cities of New York and adjoining states, especially for public structures, churches and fine residences.

The rock face which is most favored for buildings has a medium gray tone, while the cut or patent hammered surface of trimmings shows much lighter. The selling prices vary with the color and uniformity, and range up to about $4.70 a cubic foot which is the price received for the best quality of extra dark monumental stock, sand rubbed but not polished. The lighter grades of monumental stone bring from $1 to $2 less a cubic foot. The grades of the different quarries do not correspond closely, so that the terms dark, extra dark, etc., as used by the several companies are not strictly equivalent.

There seems to be some relation between the color of the marble and the stratigraphic features, though such relation may not be uniform or consistent throughout the belt. In general, however, the lighter and coarser marble is on top or in the northwestern section, while the fine-grained dark comes from the structurally lower beds on the southeast. This is indicated by the variation in the different exposures and by the results of drilling.

The St Lawrence Marble Quarries. The quarries owned by this company are near the northeastern end, two of which are close to the mill and are known as the St Lawrence quarries. The third quarry, called the extra-dark, is on a different vein to the south and east. Only the last was under operation at the time of

the writer's visit. It is an opening 125 feet long and 80 feet wide and 20 to 30 feet deep. The marble here is of medium color, mottled or veined on top, but becomes dark blue in depth which is the grade particularly sought, as the other quarries supply lighter stock of good quality. The bedding structure dips northwest 30° and pitches southwest 25°. Two vertical systems of joints intersect the beds, the one running N. 30° W. and the other N. 65° E. A trap dike from 2 to 3 feet wide crosses the quarry in the latter direction which is nearly that of the strike; it dips south at a high angle. The dike shows a serpentinous groundmass, with lath-shaped feldspars, and is probably a diabase that has been considerably weathered.

The two St Lawrence quarries near the mill are vertical rock cuts with a surface of about 20,000 square feet each and a depth in the northerly quarry of 80 feet and of 40 feet in the southerly one. They have supplied large quantities of building marble of which examples are seen in Gouverneur, Watertown, Ogdensburg, Rochester and other places. The monumental stone is mainly the selected darker quality which is sold under the trade name of "St Lawrence" but includes some lighter stone called "Adirondack." Near these quarries, a drill hole was put down which penetrated the vein for 400 feet. The dip is here about 20°.

The quarries are well equipped with six channelling machines, two gadders, and three large derricks. The mill is the largest in the district, having sixteen gangs of saws, besides rubbing beds, lathes, and polishing machines. The mill is run by electricity derived from the Hailesboro water power station.

Northern New York Marble Co. The property of the Northern New York Marble Co. lies in the southwestern section of the belt, separated from the other quarries by a long stretch of undeveloped ground. It appears to be considerably south of the course of the principal marble beds, but is possibly a continuation of the vein developed in the extra dark quarry of the St Lawrence Company. This is segregated by the similarity in the product, as well as by the relative position of the two quarries. The structural features, however, are not uniform, as the strike becomes almost east-west and the dip is very high — about 80° N. at the more westerly property. There is the same westerly pitch of the beds.

The principal quarry opening is about 140 feet long and 75 feet wide and has been worked down to 210 feet depth. This has been abandoned on account of the depth. A second quarry 100 feet south

of the first one and about the same length has been worked to a depth of from 40 to 65 feet. In 1912, the development of a third quarry was begun, situated to the west of the latter with which it will eventually connect. This covers an area of 100 feet square. The quarries are equipped with three channelling machines, two gadders and two derricks.

The marble is mostly of the darker grades, the average being darker than that found in the other quarries, and is also finer grained. It is sold under the name of "Northern New York," with three grades depending on the relative presence or absence of lighter streaks in the dark blue ground. It is mainly in demand for monumental work. A good proportion of the lighter grade is not polished, but hammer faced, and then makes a close imitation of granite.

In the upper 15 feet, the marble shows open joints and fissures along which more or less weathering and discoloration has taken place. A few fissures reach below that depth, but for the most part the stone is uniform and quite solid. There are a few knots in the quarry walls, which arise from silicate inclusions; they rarely exceed a foot in diameter. The surface of the marble shows deep groovings from glacial erosion.

The company's mill is situated at the quarries and is equipped with ten gangs and a rubbing bed. The larger part of the output of monumental marble is shipped in polished form.

The Gouverneur Marble Co. The Gouverneur Marble Co. owns quarries on the northeastern section, adjoining those of the St Lawrence Company. Its principal development is an opening 250 feet long and nearly as wide which has been worked to an average depth of 50 feet. This is being extended by a smaller connecting quarry 125 feet long and 50 feet wide on the southeast. The beds dip northwest 10° or so and have a pitch to the northeast. The jointing is mainly in two systems N. 40° W. and N. 50° E. dividing the marble into rectangular blocks. A test hole was put down in the smaller quarry to a depth of 95 feet and is said to have shown a good quality of marble for that distance.

The product runs mostly to the medium and light sorts, but some good dark is being extracted from the more southerly section. The lighter colors are often beautifully mottled or veined. A considerable part of the product goes for building stone which is shown in churches and schools in various parts of the State.

The quarry equipment comprises a derrick, two channelers and a gadder. The mill has eleven gangs of saws.

The Rylestone quarries. The Rylestone quarries, which were closed at the time of the writer's visit, lie a mile or so south of the main belt on a separate lead. They are situated on the side of a low hill and are not worked below the surface. The marble is a coarse medium to light stone, in which the blue and white are equally mixed. It lacks the uniformity of texture exhibited by the marble elsewhere and is subject to considerable loss in quarrying by reason of vugs that are apt to be disclosed in the midst of an otherwise sound block. These vugs range from very minute cavities lined with crystallized minerals to those a foot or two in length. Calcite, marcasite and brown tourmaline are the more common minerals found in them.

The quarry face is about 100 feet long at the base and 50 feet high. In the last operations, the stone has been quarried away by blasting. The product was sawed in a mill nearby equipped with eight gangs.

There are a number of quarry openings on the main belt which have been idle for some time, such as the Callahan quarry on the northeast end, the Sullivan quarry, near the St Lawrence quarries, and the quarry of the former Whitney Marble Co., on the southwest, near the property of the Northern New York Marble Company.

Southeastern New York. Crystalline limestone is found in the Highlands and the bordering metamorphosed area to the north and south. It is specially prominent on the east side of the Hudson, where it underlies many of the north-south stream valleys of Westchester, Putnam and eastern Dutchess counties. It is associated with schists, quartzites and thinly bedded gneisses, the whole series of interfolded metamorphosed sediments bearing much resemblance to the Grenville series of the Adirondacks. There is some doubt, however, as to the stratigraphic position that should be assigned to the limestone, if indeed it is to be regarded as an essentially continuous formation throughout the area.

In Westchester county the limestone is coarsely crystalline, white and usually dolomitic, but varying considerably in its magnesia content. The name "Inwood" limestone was first applied to it by F. J. H. Merrill, who later advocated the view of the general equivalence of the limestones in this section with those of western New England and withdrew that name in favor of the prior term "Stockbridge dolomite."

In the northern section in eastern Dutchess county, the lime-

stone is fine in grain and shows often a bluish color, but is still prevailingly dolomitic.

The later investigations which have been carried out chiefly by Berkey indicate the possibility of the existence of two series of limestones in the region, one of which belongs to the coarser crystalline type as represented by the Westchester county rock. This is accompanied by strongly metamorphosed sandstones and argillaceous sediments known as the Lowerre quartzite and the Manhattan schist, the whole series showing no marked unconformity with the underlying gneisses. The age of the series, according to Berkey, is Precambric and may be called Grenville. The second assemblage of sediments includes the less metamorphosed representatives that are developed mainly to the north of the Highlands and include the Wappinger limestone, the Poughquag quartzite and the Hudson River slates of Cambric and Ordovicic age. Strong unconformity marks their contact with the underlying gneiss.

The limestones throughout the area are prevailingly magnesian, though they include bands and lenses that are characterized by low magnesia. In most of the developed marble quarries the stone approaches the composition of dolomite with 30 per cent or more of magnesium carbonate. The lime carbonate varies between the lower limit of 55 per cent found in the true dolomite to 70 per cent or a little more. The siliceous impurities are usually low, not over 2 or 3 per cent in the marbles. They are due to inclusions of quartz, mica, tremolite, diopside, and more rarely tourmaline. Pyrite is usually present in small amount.

The marble in this section is found in the more massive heavily bedded parts of the formation, such as are uniform in texture and nearly free of admixture with silicates. It is predominately white, either uniformly white throughout, or white clouded or banded with blue. It has been mainly used for building stone and both for exterior and interior work. There are numerous examples of it among the larger structures of New York City, especially those erected twenty or more years ago, as at that time it enjoyed greater favor among architects than any other native marble. Of recent years fashion or the exigencies of engineering technic in connection with the very large structures have brought about a change in favor of granite, limestone and terra cotta.

In durability, the marble from the different localities no doubt varies, and the ease with which some of the stone has weathered

has caused much unfavorable comment. The tendency to rapid weathering which is announced by a roughening or pitting of the exposed surface seems to be inherent more especially in the marbles that have an even grain with the individual particles of square or rounded form. Such particles are not so well interlocked as those of prismatic shape. The weathering in most instances seems to be a mechanical process, simply a loosening of the bond through frost action or the expansion and contraction incident to changes of temperature. Normally, dolomite is harder and more resistent to the attack of solvents than calcium limestones.

South Dover Marble Co. Of the developed quarries in this section, the principal one in current operation is that of the South Dover Marble Co., situated near Wingdale, Dutchess county, a station on the Harlem Railroad. The area of crystalline limestone or marble lies on the flanks of a broad gneiss ridge which extends north and south along the New York-Connecticut boundary. The limestone shows a flat or slightly undulating surface in contrast with the rugged contours of the gneiss country. The quarries are about 2 miles in a direct line northeast of Wingdale, but somewhat over that distance by road. They are connected with the mill at the station by an electric tramway over which the large quarry blocks are transferred for cutting.

The company operates two quarries, the one being on the east slope of a low ridge facing the gneiss ridge and the second a little farther up the slope and northwest of the former. The lower quarry has an extreme length of 250 feet and a width of 150 feet in the southern half, but considerable less on the north. It is 135 feet in extreme depth. There are three derricks in place. The other opening is 150 feet long, 75 feet wide and about 60 feet deep. It has two derricks and an overhead cableway, the latter serving to convey the waste to the dump.

The marble is of medium texture, with prismatic and angular dolomite particles which measure from .75 to 1 mm. in diameter. It is practically pure white in color, and banding or veining is scarcely noticeable. The structure, as exhibited in the quarry walls, indicates an easterly dip of about 40° for the southern quarry and a westerly one of 50°–60° in the northern one, the reversal taking place in the distance of 100 feet. The marble is very compact, though in one place an open joint or water course extends to a depth of 50 feet. It shows slight exfoliation and weathering at the surface, with stained rock to a depth of 10 feet.

There is a little pyrite in evidence, mainly collected along stringers and occasional knots of silicates. The marble seems to be delimited on the west by a hard white quartzite which forms the higher part of the ridge and is exposed 75 feet west of the quarry opening. The strike of the marble beds is a little east of north. The quartzite intervenes between these quarries and that of the Dover White Marble Co.

At the cutting works at Wingdale, the company has a complete equipment for cutting, planing and polishing its product.

The Dover White Marble Company. The Dover White Marble Co. has a quarry and mill on the east bank of Tenmile creek about one and one-half miles northwest of the quarries of the South Dover Company. The quarry is about 100 feet square and 20 feet deep on the west or downhill side and 40 feet on the east side. The marble is rather uneven in appearance, showing small bands of gray which are more pronounced in the western section and which are regarded as variations of bedding. The bands are of sericitic and quarzitic nature, derived from argillaceous and sandy layers included in the limestone. The beds strike N. 10° E. and dip 80° E. They undulate in folds and the siliceous layers are often squeezed out into lenses around which the marble has flowed under pressure. An imperfect jointing is present along the direction of the bedding. Blind checks and seams cause considerable loss in cutting. The grain is finer than that of the South Dover product, averaging less than .5 mm.

The product has been employed mainly for veneer and wainscoting. The blocks are sawed across the bedding, or horizontally, as they lie in the quarry. The company ceased active work in April 1912.

In the southern part of the region in Westchester county and the Bronx no systematic quarry operations have been carried on in several years. Some of the quarries of this section, like those at Tremont, Tuckahoe and Pleasantville, were operated at one time on a large scale for architectural stone. The marble makes a good appearance, being mostly clear white, but is very coarse grained. On that account it is not so suitable for interior or polished work as the marble from the more northerly quarries. The only use that is made of the stone at present is for lime or crushed stone.

At the Tuckahoe quarries, formerly worked by Norcross Bros., the Emerson-Norris Co., of New York, has erected a plant for

making artificial stone, using the waste from the former operations. The marble is used with white portland cement to make a very light-colored product, or mixed with darker rock, in which case the finished material is a close imitation of granite. The stone, after casting in molds, is usually hammer dressed.

The Kapailo Manufacturing Co. has a crushing plant at the old Tuckahoe Marble Company's quarry where it makes crushed stone, sand and dust for concrete and stucco. The company has recently pumped out the quarry which it intends to operate for its uses.

SANDSTONE

Under sandstones are included the sedimentary rocks which consist essentially of quartz grains held together by some cementing substance. Among the varieties distinguished by textural features are sandstones proper, conglomerates, grits and quartzites.

Of the sedimentary rocks which occur in the State, sandstone has the largest areal distribution, while in economic importance it ranks second only to limestone. Nearly all the recognized stratigraphic divisions above the Archean contain sandstones at one or more horizons. The kinds chiefly quarried are the Potsdam, Hudson River, Medina and Devonic sandstones. A few quarries have been opened also in the Shawangunk conglomerate and the Clinton and Triassic sandstones.

The Potsdam of the Upper Cambric is the lowest and earliest in age of the sandstones that have a fairly wide distribution and are utilized for building purposes. The most extensive outcrops are along the northern and northwestern borders of the Adirondacks, in Clinton, Franklin, St Lawrence and Jefferson counties. Other exposures of smaller extent are found in the Lake Champlain valley and on the southeastern edge of the Adirondack region. These latter areas represent the remnants of a once continuous belt that has been broken up by folding, faulting and erosion. The Potsdam sandstone has in many places the character of a quartzite, consisting of quartz grains cemented by a secondary deposition of quartz, and then is a very hard, tough and durable stone. The quartzite from St Lawrence county has sustained a crushing test of more than 42,000 pounds to the square inch. The color varies from deep red to pink and white. The principal quarries are near Potsdam and Redwood, St Lawrence county, and Malone and Burke, Franklin county. Besides building stone, which is the chief product, there

is some flagstone sold, mainly by the quarries at Burke, for shipment to Montreal.

The so-called Hudson River group is essentially a group of sandstones, shales, slates and conglomerates, ranging in age from the Trenton to the Lorraine, but which have not been sufficiently studied to permit the actual delimitation of the various members on the map. The group is exposed in a wide belt along the Hudson from Glens Falls southward into Orange county and also in the Mohawk valley as far west as Rome. The sandstone beds are usually fine-grained, of grayish color and rather thinly bedded. Over wide stretches they provide practically the only resource in constructional stone and consequently they have been quarried at a great number of places to supply the local needs for building and foundation work. Some of the stone is crushed for road metal and concrete.

The Medina sandstone is found along the southern shore of Lake Ontario from the Niagara river east to Oswego county; in central New York it is represented by a coarse conglomeratic phase called the Oneida conglomerate. As developed in the western part of the State, where it is principally quarried, it is a hard fine-grained sandstone of white, pink and variegated color. The pink variety is specially quarried for building stone and has an excellent reputation. Many of the large cities of the country and most of the important towns and cities of the State contain examples of its architectural use. The large quarries are situated in Orleans county, near Albion, Holley and Medina, along the line of the Erie canal, but there are others at Lockport and Lewiston, in Niagara county and at Brockport and Rochester in Monroe county. The Medina sandstone also finds extensive application for curbing and flagging and for paving blocks. It is employed more extensively for the latter purpose than any other stone quarried in the State.

The Shawangunk conglomerate is more widely known for its use in millstones than for constructional purposes. It outcrops along Shawungunk mountain in Ulster county and southwesterly into New Jersey, with an outlier near Cornwall, Orange county. The quarries near Otisville have supplied considerable quantities of stone for abutments and rough masonry.

The Clinton sandstone is mainly developed in central New York, being absent from the Clinton belt in the western part of the State. It forms ledges of considerable extent on the south side of the Mohawk valley from Ilion to Utica and beyond. It consists of

reddish brown and gray sandstones, of medium texture and hardness. The stone has been used for foundations and building in Utica and other places in the vicinity.

Of the Devonic formations which cover about one-third the whole area of the State, the Hamilton, Portage, Chemung and Catskill contain important sandstone members serviceable for quarry operations. These sandstones are popularly known as bluestone, a name first applied in Ulster county where they are distinguished by a bluish gray color. They are for the most part fine-grained, evenly bedded, bluish or gray sandstones, often showing a pronounced tendency to split along planes parallel to the bedding so as to yield smooth, thin slabs. For that reason they are extensively used for flag and curbstone, and a large industry is based on the quarrying of these materials for sale in the eastern cities. Most flagstone is produced in the region along the Hudson and Delaware rivers, where there are convenient shipping facilities to New York, Philadelphia and other large cities. The Hudson River district includes Albany, Greene and Ulster counties, but the quarries are mainly situated in the area that includes southern Greene and northern Ulster, with Catskill, Saugerties and Kingston as the chief shipping points. The Delaware River district includes Sullivan, Delaware and Broome counties; the shipping stations are along the Erie and the Ontario & Western railroads. The sandstone of this section ranges from Hamilton to Catskill age. In the area to the west the quarries are confined to the Portage and Chemung groups, with the most important ones in the Portage. There are large, well-equipped quarries near Norwich, Chenango county, and Warsaw, Wyoming county, which produce building stone for the general market. Numerous small quarries are found in Otsego, Chemung, Tompkins, Tioga, Schuyler, Steuben, Yates, Allegany, Cattaraugus and Chautauqua counties.

Production of sandstone. The quarrying of sandstone is carried on by a large number of individuals and firms, more in fact than is represented in any other branch of the quarry business. Most of these operate in the bluestone districts and specially in those where flagging and curbing are the principal products. The quarrying of these materials is practically a separate industry represented by several hundred more or less independent enterprises which are usually small, giving employment to two or three workmen each and having very little in the way of mechanical equipment. A statis-

tical canvass of such small and temporary enterprises is a matter of great difficulty and is likely to afford very unreliable results. For that reason the statistics in this report are mostly based on statements furnished by dealers who operate in the bluestone districts and who act as middlemen between the individual quarries and the larger contractors or consumers in New York and other large cities. The larger part of the curb and flagstone in the Delaware and Hudson River districts is handled by such dealers.

The production of sandstone during the last two years is shown in the accompanying tables which give its distribution also among the leading districts.

The quarries of both bluestone and ordinary sandstone were slightly more active last year than in 1911. The combined value of all the sandstone quarried was $1,280,743 against $1,060,106 in the preceding year. The gain of $220,637 or about 20 per cent, did not restore the industry to its position in the year 1910, when the value of the output amounted to $1,451,796. The totals are exclusive of any sandstone quarried by contractors for use on the State highway system, for which it is impossible to assign any accurate figure.

Of the total value of the output for 1912, bluestone constituted a little less than two-thirds, in actual figures, $824,949. In the year 1911, it had a value of $718,777, indicating a good gain, but not counterbalancing the declines of preceding years. The flagstone industry has met with increasing competition from makers of cement walks and the output has shrunk to less than half of its former proportions. The total for flag and curbstones was $503,189 against $432,327 in 1911. The value of bluestone used for building purposes was $295,450 as compared with $280,300 in 1911. The other uses are relatively unimportant.

Sandstone other than bluestone constituted a value of $455,794 against $340,729 in 1911. The main item in the total was paving blocks valued at $188,802 against $162,220. Orleans county, which is the principal center of the Medina sandstone industry, accounted for a total value of $340,796, as compared with $225,862 in the preceding year.

Production of sandstone in 1911

DISTRICT	BUILDING STONE	CURBING AND FLAGGING	PAVING BLOCKS	CRUSHED STONE	RUBBLE RIPRAP	ALL OTHER
Bluestone						
Hudson river	$24 393	$218 216	.....	.....	$560	$200
Delaware river	31 775	204 629	.....	.....	1 775	1 245
Chenango co	72 933	9 482	.....	.....	250	1 210
Wyoming co	145 519	.....	.....	$600	910	.....
Other districts	5 680	.....	.....	.....	.....	.....
Total bluestone	$280 300	$432 327	.....	$600	$3 495	$2 655
Sandstone						
Orleans co	$21 395	$83 519	$145 575	$1 081	$4 257	$35
Other districts	25 892	10 228	16 645	22 202	6 913	2 987
Total sandstone	$47 287	$93 747	$162 220	$23 283	$11 170	$3 022
Combined total	$327 587	$526 074	$162 220	$23 883	$14 665	$5 677

Production of sandstone in 1912

DISTRICT	BUILDING STONE	CURBING AND FLAGGING	PAVING BLOCKS	CRUSHED STONE	RUBBLE RIPRAP	ALL OTHER
Bluestone						
Hudson river	$9 674	$270 544	.....	$4 000	$10 000	$1 216
Delaware river	42 944	220 601	.....	.....	5 367	997
Chenango co	85 622	4 876	.....	.....	250	2 237
Wyoming co	151 255	5 488	.....	660	483	1 100
Other districts	5 955	1 680	.....	.....	.....	.....
Total bluestone	$295 450	$503 189	.....	$4 660	$16 100	$5 550
Sandstone						
Orleans co	$35 660	$99 074	$185 432	$1 551	$6 723	$12 356
Other districts	31 945	13 583	3 370	39 090	15 930	12 080
Total sandstone	$67 605	$112 657	$188 802	$40 641	$21 653	$24 436
Combined total	$363 055	$615 846	$188 802	$45 301	$37 753	$29 986

The quarries in the Medina section were fairly active last year, favored by a good demand for materials used in street work. Curbstone and paving blocks constitute the main products of the quarries, considerably exceeding in value the building stone which once enjoyed wide popularity. These materials are marketed in Rochester, Buffalo, Cleveland and other lake cities, to which the stone

is shipped by boat, as the barge canal passes directly through the district. For paving blocks the sandstone seems specially adapted by reason of its qualities of wearing evenly and not becoming readily rounded or "turtle-backed," which is a fault in many stone pavements. The use of blocks is superseding asphalt in paving between car tracks in city streets. There are a large number of quarries in the section from Medina to Holley, but many of these are closed at present. The tendency in the district has been toward a concentration of operations at a relatively few quarries which are well equipped and actively worked, in contrast with the small and scattered enterprises in the eastern bluestone districts.

TRAP

The quarrying of trap is a somewhat specialized branch of the stone industry which may be treated with advantage under a separate head. Trap is not a distinct rock type, but the name properly belongs to the fine-grained, dark-colored igneous rocks that occur as intrusive sheets or dikes. In mineral composition it differs from the other igneous rocks classed in the trade as granite, by the prevalence of lime-soda feldspars and higher percentages of the lime, magnesia and iron minerals and correspondingly lower amounts of silica, with little or no free quartz. The name is sometimes applied to fine-grained rocks of granite or syenitic composition and even to rocks of sedimentary derivation, but such usage is misleading and indefensible.

The particular value of trap is due mainly to its hardness and toughness. Its fine, compact homogeneous texture gives it great wearing powers and it is eminently adopted for road metal and for concrete of which heavy service is required. It has been used in this State to some extent as Belgian blocks. As a building stone it finds very little application, probably on account of its somber color. The expense of cutting and dressing trap is also an obstacle to its employment for building or ornamental purposes.

The trap quarried in New York is properly a diabase, made up of plagioclase feldspar in lath-shaped crystals and pyroxene as the main constituents, and amphibole, olivine and magnetite as subordinate minerals. The largest occurrence is represented by the Palisades of the Hudson, which begin near Haverstraw and extend southward into New Jersey. The Palisades represent the exposed edge of a sill or sheet of diabase intruded between shales and sandstones of Triassic age. The sheet is from 300 to 800 feet thick and about 70 miles long. Most of the trap quarried in this State

has been obtained from this region, chiefly from the vicinity of Haverstraw and Nyack, but to some extent from near Richmond, Staten Island, where the sheet has its southern termination. Smaller occurrences of diabase are found in the Adirondacks and the bordering area. There are countless numbers of trap dikes in the interior of the Adirondacks, but very few have any considerable thickness and in general they are too remote from the market to be profitably quarried. In the outlying region the dikes at Greenfield, Saratoga county, and at Little Falls, Herkimer county, are the most notable. Quarries have been opened at the former locality and the trap is crushed for road material.

Production. The trap industry in Rockland county has been in an unsettled state during the past year, owing to the development of the plans for the Palisades Park. The lands to be set aside for the latter include a strip along the river that covers the more accessible part of the trap intrusions, and the abandonment of all operations in that section of Rockland county is in prospect. So far, only the property of the Manhattan Trap Rock Co., of Nyack, has been actually taken over and closed down previous to the opening of last season, but the contribution from other quarries was considerably reduced.

The value of the trap produced in 1912 was $483,863 as compared with $899,414 in 1911 and $909,006 in 1910. The whole output consisted of crushed stone, although in previous years building stone and paving blocks have also been produced to some extent. The quantity of crushed stone made was 675,309 cubic yards, of which 283,628 cubic yards, with a value of $207,957 was reported as sold for road purposes and 391,681 cubic yards valued at $275,906 for railroad ballast, concrete and other purposes. Altogether, there were six firms represented in the industry, of whom five operated in Rockland county and one in Saratoga county.

Production of trap

MATERIAL	1911		1912	
	CUBIC YARDS	VALUE	CUBIC YARDS	VALUE
Crushed stone for roads	850 322	$696 367	283 628	$207 957
Crushed stone for other purposes	267 930	199 797	391 681	275 906
Other kinds	185	3 250	.....	.....
Total	1 118 437	$899 414	675 309	$483 863

TALC

The talc mines in the Gouverneur district were under steady operation throughout 1912 and contributed about their usual output which was shipped for the most part in ground condition for use in paper, wall plasters and other purposes. The district has supplied for some time the greater part of the ground talc produced in this country. During the last twenty years the annual outturn has ranged from 40,000 tons as a minimum to a maximum of about 70,000 tons; the total quantity mined from the first may be placed at 1,450,000 tons with a value on the average market basis of approximately $12,000,000. This very considerable item in the mineral yield of the State has not caused any serious drain upon the resources, so far as can be estimated, for the development of new mines has fairly kept pace with the depletion of supplies in the older workings while there are still many possibilities for the occurrence of additional deposits within the long stretch of territory that constitutes the district.

The principal features of the occurrence of the talc and present methods of its mining and milling were described in the preceding issue of this report. The past season has witnessed no important developments which call for any revision of the information contained in the article, except that the list of active companies was increased by the entrance of the Standard Talc Co. into the field. This company, however, did not operate a new mine, but took over the old United States mine, at Talcville, which had been under lease to the International Pulp Co. The product was shipped to New Jersey for grinding, as the mill formerly connected with the mine was burned down some time ago.

The Uniform Fibrous Talc Co. which began production in 1911 was active throughout the year, continuing the development of its mines as well as preparing for an enlarged milling capacity. The mine has been developed practically from the surface. It lies a little west of Talcville on the north bank of the Oswegatchie river. The deposit appears to be nearly in the same horizon as that worked in the United States and No. 2½ mines at Talcville. The shaft is vertical for the first 90 feet, then follows the northerly dip of the talc; at the end of 1912 it had reached a depth of a little over 200 feet. The talc body has been explored for a width of 30 feet without coming into the unaltered tremolite schist which forms the walls. It yields a very white talc of fibrous nature. An addition to the mill recently completed, provides space for the

crushing machinery, so that the crushing and grinding can be conducted in separate rooms, a great factor in relieving the dusty conditions that are often very objectionable if not unhealthful.

The International Pulp Co., whose activity in former years was divided among a large number of mining and milling properties secured by repeated consolidations and by leaseholds, has concentrated attention recently upon a few which are more advantageously situated. The principal mines now worked are No. 2½ and No. 3 at Talcville, and the Wight mine near Sylvia lake. The operation of No. 3 mine was hampered during the last year by the loss of the water power plant at Talcville, but a new steam plant has been installed. The mine is one of the largest in the whole district, having a depth of about 500 feet on the incline and a system of levels which extends nearly double that distance along the strike. The working thickness of the body ranges from 15 to 40 feet. The Talcville mill was burned down with the power plant and only No. 6 and the Columbia mill were steadily operated.

The Ontario Talc Co., with mine and mill near Fullerville, was a steady producer.

The new developments in talc mining at Natural Bridge have been attended with much interest as the first important undertaking of the kind outside of the Gouverneur district. The property began regular shipments of talc with the completion of the mill last season; and the initial operations are reported to have been very successful, as the product proved well adapted for paper manufacture. The St Lawrence Talc Co., Inc., the owner, has already begun the enlargement of its milling capacity and continued the development of the mine. The talc from this section, as has been already mentioned in earlier reports, differs from the characteristic Gouverneur product which for the most part is of fibrous nature with subordinate amounts of foliated or scaly talc. The material at Natural Bridge, however, has a massive appearance, or at most shows an indistinctly granular habit, and is really a complex of alteration products. The color is prevailingly grayish, but there is also more or less of a greenish waxy substance intermingled with the gray talcose minerals. The green comes in part from serpentine, but mostly is referable to a chloritic mineral which has a compact massive appearance, lacking the cleavage that characterizes ordinary chlorite. Chemical analysis confirms the presence of such a mineral which may be identical with the variety called pseudophite. The apparently massive talc resolves itself under the microscope into

an aggregate of finely divided scales which are arranged into more or less distinct groups, at times of prismatic form and again quite irregular. There is some indication of the former presence of minerals of the amphibole and pyroxene families, but just what their proportions may have been or their contribution to the present mineral association can not be stated from the little study that has been given the specimens. The vicinity of the deposits has long been a familiar locality to the mineral collector and yields quite a variety of species that are, as a whole, characteristic of the limestones when intruded and metamorphosed by deep-seated intrusives.

The production of talc by the several companies above mentioned amounted last year to 61,619 short tons, valued at $511,437. The total was a little less than that for 1911 which amounted to 65,000 short tons with a value of $552,500. The prices ranged from $8 to $9 a ton for the grades sold to the paper trade, the principal product; for the other grades they were somewhat lower.

Production of talc in New York

YEAR	SHORT TONS	VALUE	YEAR	SHORT TONS	VALUE
1881	5 000	$60 000	1897	57 009	$396 936
1882	6 000	75 000	1898	54 356	411 430
1883	6 000	75 000	1899	54 655	438 150
1884	10 000	110 000	1900	63 500	499 500
1885	10 000	110 000	1901	62 200	483 600
1886	12 000	125 000	1902	71 100	615 350
1887	15 000	160 000	1903	60 230	421 600
1888	20 000	210 000	1904	65 000	455 000
1889	23 476	244 170	1905	67 000	519 250
1890	41 354	389 196	1906	64 200	541 600
1891	53 054	493 068	1907	59 000	501 500
1892	41 925	472 485	1908	70 739	697 390
1893	36 500	337 625	1909	50 000	450 000
1894	50 500	454 500	1910	65 000	552 500
1895	40 000	320 000	1911	65 000	552 500
1896	46 089	399 443	1912	61 619	511 437

ZINC

The Northern Ore Co. continued the development of its zinc property near Edwards, but did not engage in active commercial operations. By reason of the occurrence of pyrite in much of the ore, mill treatment is essential in order to dispose of the blende to advantage. There is, moreover, considerable low-grade material

that should pay for concentration. A mill was erected at the mines early in the year and experimental runs were made which resulted in a small output of concentrates. The milling process was based on a combination of gravity and magnetic separation without preliminary roasting, the design being to save the pyrite as well as the blende. Though experimental runs seemed to indicate the feasibility of the process, difficulty was found in carrying it out on a working scale. The mill was intended to treat 50 tons of crude ore a day.

Exploration of the ore bodies was confined mainly to the southern end of the Edwards property, on the Brown farm, where a shaft had been under way in the preceding year. This was sunk to a depth of 350 feet measured on the dip which averages perhaps 35°. Though the band or vein of ore in which the shaft started was found to pinch below, other bodies were encountered so as to afford stoping ground for most of the distance to the depth mentioned. There appeared to be little change in the character of the ore. At the 100 foot level the ore band was explored by a drift to the southwest, which, 100 feet from the shaft, came out into the surface clays that fill the adjoining valley. An adit, extended to the northwest from the drift, ran into a second band that was followed for some distance. Exploration was conducted also at depths of 200, 300 and 350 feet along the vein, constituting a series of levels from which ore will be mined when active operations are begun.

A little work was performed also a little farther north in a second shaft situated across the ridge and about 600 feet distant from the first. At this point the ore at the surface is not in a solid band of sulphides, but occurs as a zone of crushed and brecciated material in which the blende and pyrite form angular disjointed blocks with limestone as the matrix or cementing substance. The width of the zone is about 15 feet in maximum. It has been followed in the shaft to a depth of a little over 100 feet.

The work at Edwards has served naturally to stimulate interest in the mining possibilities of the region. The belt of limestones which contains the ore bodies extends southwest across the town of Edwards to Sylvia lake in the town of Fowler, a distance of about 12 miles. Recent prospecting has resulted in the discovery of additional occurrences of zinc blende at different localities within the belt. For information as to some of the occurrences not hitherto mentioned, the writer is indebted to Mr Homer L. Drake, of Gouverneur.

The existence of zinc ore on the Balmat property, in the southwestern section near Sylvia lake, has been known since the early part of the last century and is probably the first to have been discovered in this section. The property belongs to the Northern Ore Co., but as yet has not been prospected to any extent.

A deposit that must have been known for some time but has escaped general attention occurs on the Streeter place, northeast of the Balmat. It has the form of a vein or band outcropping along the side of a low ridge which it follows apparently quite a distance. The deposit has been prospected in one place and shows a width of 4 or 5 feet. The ore resembles that at Edwards.

There is a small showing of blende on the Tamlin place, near the highway and east of the Balmat property.

Zinc blende in association with a massive or earthy hematite is found on the property of the Dominion Mining Co., near Sylvia lake. The deposit was once worked for iron ore which was used at the Fullerville furnace. The blende forms small grains which with pyrite are found in seams and nodules within the iron ore, but more specially along the contact of the iron ore and walls. The opening was pumped out and explored to some extent during the year. The company is mainly interested in talc which it has uncovered on the same property.

The existence of zinc blende is reported on the Cole place near the Potter talc mine, but has not been confirmed by the writer. Another reported occurrence that could not be confirmed is on the Sullivan place where blende and pyrite are said to have been found in the excavation for the water power development owned by the Uniform Fibrous Talc Co.

On the road from Edwards to Fullerville, about two miles southwest of the former place, there is a large outcrop of pyritic quartz schist which is very noticeable on account of the stained and burnt appearance of the ledges. On the McGill farm, nearby, crystalline limestone is exposed in several places and has been found to carry zinc blende. A prospect on a side hill south of the highway exposes a strip of the limestone about 9 feet long and 3 feet wide which is more or less charged with the sulphide. Another occurrence is found a little north of this. The limestone has not been sufficiently explored to indicate the extent of the mineralization.

It is worthy of note that the limestone in the vicinity of the sulphide bodies is always heavily charged with silicates, mainly talc and serpentine. The occurrences are usually close to some of the

talc seams occurring nearly always on the southern or footwall side of the latter. The association of the silicates and sulphides is of considerable interest for the study of the derivation of the ores.

The zinc appears to have been introduced into its present place by underground circulations and deposited mostly as a replacement of the limestones, very little as a filling of open fissures. The view as to the secondary nature of the deposits is supported by their variable form, which ranges from narrow seams or bands to lenses and again to very irregular shapes. The seams, in places, also break across the bedding of the limestones. The horizon of the ore varies considerably within the limits of a single locality as at Edwards and in such a way as to be hardly explainable by structural disturbances of once continuous seams or beds.

That the ores have replaced the limestones is indicated by the lenticular or quite irregular forms assumed by the bodies, as above noted, by the gradation along the borders from the rich sulphides to leaner material and finally to barren limestone, and further by the absence of banding in the arrangement and of drusy cavities which characterize the fillings of open spaces. The ore body opened by the southern shaft at Edwards, however, has quite well-defined parallel walls as seen near the surface which may mark a fissured zone or channel followed by the ore-bearing solutions.

The specimens frequently exhibit nodules of talc and serpentine. These range from very small size — a fraction of an inch in diameter — up to nodules measuring a foot or more across. They are practically barren of sulphides, except such as have been fractured when the ore may be seen to extend into or across the nodules, following the seams. The nodules more often than not consist of a talc core with a surrounding shell of serpentine. The talc has a massive appearance in the hand specimens, not fibrous like the usual product of the talc mines in the vicinity; whether it has originated from alteration of tremolite or has possibly been formed directly from solutions in the period of metamorphism of the limestone can not be stated at this time. At any rate, the mineral associations indicate that the nodules, so far as represented by the talc cores, existed before the ores were deposited, though the serpentine is in part of later formation.

The serpentine which encrusts the nodules belongs to the massive variety and shows no evidence of being pseudomorphic after an anhydrous silicate. Its relations rather suggest a reaction product

between the talc and the dolomitic limestone. Veinlets and threads of the same type of serpentine are found intersecting the sulphide bodies, the mineral here having been deposited from solution subsequent to the introduction of the ores.

Vein quartz is much in evidence around the ore bodies, specially those at Edwards; at this locality a band of white quartz 10 feet thick is exposed near the southern workings with a strike parallel to that of the ore bodies. There are numerous smaller stringers that intersect the limestone in all directions. Inclusions of talc were found in the quartz and it apparently represents a relatively late period of deposition.

The general association of the sulphides and accompanying minerals seems to bear evidence of the work of underground waters, which in an extended period of circulation through the limestones have introduced and deposited various ingredients. To the earliest stage of their activity is perhaps to be assigned the partial dolomitization and silication of the limestones which resulted in the formation of talc. It is recognized that the latter may have been derived from tremolite as is the case of most of the talc in the near-by talc district, but tremolite itself is a secondary mineral that was found either as the result of metamorphism of impure siliceous seams within the calcareous sediments or else from the reaction of silica-bearing solutions upon the limestones after their deposition and uplift. Without going into details of evidence, it may be said the latter view seems rather more probable. The underground waters next brought in iron and zinc, depositing them as sulphides in molecular interchange with the limestone. Following this, the limestones were subjected to compression which resulted in a brecciated condition, together with a certain amount of flowage, as shown in the Edwards exposures. The occurrence of quartz and serpentine stringers is to be assigned to a later period of deposition subsequent to that of the sulphides.

The compact nature of the ores, their fine granular condition and the general absence of characteristic vein types or structures, all suggest that they were deposited in their present place when the limestones were at considerable depth under cover of a heavy overburden. These conditions were undoubtedly present when the limestones underwent metamorphism and recrystallization, but that change seems to have been accomplished mostly previous to the formation of the ore bodies.

The occurrence of vein quartz of the same character as that associated with the granites and pegmatites of the surrounding region is the only indication, so far as observed, of the possible influence of igneous agencies in the introduction of the ores. The whole area of gneisses and schists bordering the limestone belt shows frequent intrusions of granite and pegmatite, offshoots apparently of some neighboring or underlying granite body. With the feldspathic pegmatites are found quartz veins in such relation as to indicate a common source. No close correlation in time can be made between the period of ore foundation and the invasion of the granite, but the latter can be confidently assigned to the later part of the Precambric. If the view as to the deposition of the sulphides in depth, rather than near the surface, is correct, then they also probably belong to the Precambric, as erosion has not been very marked upon the limestones since that period. The fact that the ores show effects of regional compression, though not to the same extent as their wall rocks, is a further argument in favor of a Precambric age, as there has been little disturbance of that nature in subsequent time. The intrusion of the granite, if not actually contributing to the body of underground waters, would have facilitated their circulation and added to their chemical efficiency.

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Published fortnightly

No. 550 ALBANY, N. Y. SEPTEMBER 1, 1913

New York State Museum

JOHN M. CLARKE, Director

CHARLES H. PECK, State Botanist

Museum Bulletin 167

REPORT OF THE STATE BOTANIST 1912

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ALBANY

THE UNIVERSITY OF THE STATE OF NEW YORK

1913

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THE UNIVERSITY OF THE STATE OF NEW YORK

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With years when terms expire

(November 1, 1913)

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New York State Education Department
Science Division, February 14, 1913

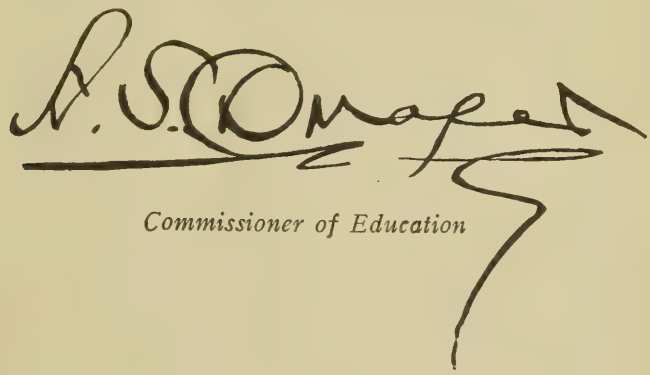
Hon. Andrew S. Draper LL.D.
Commissioner of Education

SIR: I have the honor to transmit herewith the manuscript and accompanying illustrations of the annual report of the State Botanist, for the fiscal year ending September 30, 1912, and I recommend the same for publication as a bulletin of the State Museum.

Very respectfully
JOHN M. CLARKE
Director

STATE OF NEW YORK
EDUCATION DEPARTMENT
COMMISSIONER'S ROOM

Approved for publication this 19th day of February, 1913



Commissioner of Education

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JOHN M. CLARKE, Director
CHARLES H. PECK, State Botanist

Museum Bulletin 167

REPORT OF THE STATE BOTANIST 1912

Dr John M. Clarke, Director of the State Museum:

I have the honor of submitting the following report of work done in the botanical section of the State Museum since the date of my last report.

The collections of the season of 1911 have been mounted on herbarium sheets or placed in pasteboard boxes suitable for their reception and arranged in their proper places in the herbarium. Additional specimens of plants either native or naturalized have been collected in the counties of Albany, Essex, Lewis, Livingston, Monroe, Steuben and Sullivan.

Specimens have been contributed that were collected in the counties of Albany, Chautauqua, Cattaraugus, Clinton, Columbia, Fulton, Hamilton, Herkimer, Monroe, New York, Oneida, Ontario, Onondaga, Orleans, Oswego, Rensselaer, Richmond, Schoharie, Suffolk, Tompkins, Ulster, Warren and Washington.

Correspondents have contributed extralimital specimens that were collected in Canada, California, Colorado, Connecticut, Cuba, District of Columbia, Indiana, Kansas, Kentucky, Maine, Maryland, Massachusetts, Michigan, Minnesota, Montana, New Hampshire, New Jersey, North Carolina, Ohio, Pennsylvania, Utah and Vermont.

The number of species of which specimens have been added to the herbarium is 278, of which 72 were not before represented therein. Of these, 11 are considered new or hitherto undescribed species.

A list of the names of the added species is marked "Plants added to the herbarium." These are divided into two groups

respectively designated plants "New to the herbarium" and plants "Not new to the herbarium."

The number of those who have contributed specimens of plants is 70. This list includes the names of those who sent specimens for identification only, if the specimens were of such character and condition as to make them desirable additions to the herbarium.

The number of identifications made is 1859; the number of those for whom they were made 136.

A list of the names of the contributors and their respective contributions is marked "Contributors and their contributions."

The names of species new to our flora with their respective localities, times of collection and remarks concerning them will be found under the title "Species not before reported." This may include such plants as have previously been considered forms or varieties of other species, but which are now considered worthy of specific distinction.

New localities of rare species, new varieties and any facts of interest that may have been observed will be mentioned under the title "Remarks and observations."

Species sent for identification, if collected outside the limits of our State, have been described under the heading "New species of extralimital fungi," when no description could be found to match them.

Two species of mushrooms have been tried for their edible qualities, and though neither can be considered first class in all respects, both have been found to be harmless and palatable and have been approved as edible. Colored figures of them have been prepared and descriptions will be given in a chapter on "Edible fungi." These make the whole number of New York species and varieties of mushrooms now known to be edible 215.

A small but attractive looking mushroom was discovered growing among decaying pine leaves in Richmond county by Mr W. H. Ballou. He found it to be very poisonous. It is therefore figured and described as a poisonous fungus.

Specimens of seven species of Crataegus or thorn bushes have been added to the herbarium. Of this genus of trees and shrubs 218 New York species are now recognized. Prof. C. S. Sargent, the eminent expert crataegologist, has kindly prepared a synoptical key to our New York species. This was a most difficult and intricate piece of work which none but an expert in this peculiar branch of botany could well do. In this work he has laid an

excellent foundation for the study of these interesting though often considered nearly worthless and annoying shrubs and trees. He has also added to this, descriptions of 25 new species of this genus.

In places where the chestnut bark disease, Diaporthe parasitica Murrill, has obtained a foothold it still continues its destructive work. The chestnut tree is common in the central and eastern parts of Rensselaer county. Its bark disease has been reported from both the northern and southern borders of the county. Two visits have been made the past season to the town of Sand Lake in the central part of the county to look for the disease, but hitherto no evidence of its presence there has been found. It seems remarkable that the disease should occur in the northern and southern borders only, unless its approach has been made from two different points of infection situated in nearly opposite directions from the center of the county. With the disease both in the northern and in the southern borders it is perhaps too much to expect that the intervening space can long escape attack. It would be well for the owners of chestnut timber land to keep a sharp lookout for it and promptly remove any affected trees that may be discovered, strip off the bark and burn it at once, that the disease may be kept in check as much as possible.

A small rocky knob at the north end of Lake Placid in Essex county is locally known by the name Eagles eyrie. It is covered with woods, the prevailing trees being red spruce and paper or canoe birch. These vie with each other in the size and length of their trunks. I have seen no more stately and no finer specimens of them in any other part of the Adirondacks. The trail leading from the shore of Lake Placid to the top of this mountain is about half a mile long and neither very rough nor very steep. At three stations on this trail the leaves of the striped maple, Acer pennsylvanicum L., were wilted and drooping. An examination of the base of the trunk revealed a mass of white mycelioid filaments infesting it and the roots. The fungus was not in fruiting condition and its systematic location could not be ascertained. The attack was apparently so severe that it doubtless will eventually destroy the lives of the diseased trees.

Near the red schoolhouse in the town of North Elba, Essex county, there is a patch of shrubs of wicopy or leatherwood,

Dirca palustris L. It occupies about half an acre of wooded hillside. The trunks range in diameter from one-fifth cm at or near the base, and are often free from branches for one or two feet (30–60 cm). In this case the shrubs assume a treelike aspect. In these shrubs the medullary rays are quite as conspicuous as the annular rings. They are zigzag in direction and anastomose. Thin cross sections of the trunk may easily be crumbled between the thumb and fingers into small angular fragments, the cleavage following the medullary rays as well as the annular rings. These thin cross sections, even of trunks an inch or an inch and a half in diameter, may easily be made with an ordinary pocket knife without splitting or laceration by using a little pressure on the standing trunk in the direction of the cut at the time of cutting. The largest shrub of this kind that has come under my notice is one transplanted into a dooryard many years ago. Its trunk at the base is now about 9 inches or 22.5 cm in diameter. The root of this shrub is yellow and much branched. On sloping ground it is often slightly bent or somewhat decumbent in the upper part and tapers downward like a tap root, but it is much branched. Although the name "leatherwood" is often applied to this shrub the wood itself is quite soft and brittle. It is the bark that is really the tough and leathery part of the plant. Therefore "leatherbark" would be a more appropriate name. It is probable that an exceedingly strong kind of rope or cordage could be made of this bark. The Indians are said to have used the branches for cords but it is evident that the bark was the valuable factor in their material. It might be worth while to experiment a little with the fiber of the bark to see if it could not be used in making a coarse strong canvas suitable for sacks, bags, tents or sails.

The prevailing weather in the spring of 1912 was, in the eastern part of the State, unusually cool and vegetation in consequence was late and backward. On the night of June 14th a frost occurred in the vicinity of Albany sufficiently severe to kill young foliage on many small shrubs and herbs and the tender marginal cells of the younger leaves of others and on some trees. The rainfall for this month was below the mean, and the early outlook for vegetation was not encouraging; but later, conditions became more favorable, vegetation revived and rarely have we had a more fruitful and productive season.

One of our thorn bushes, Crataegus helderbergensis Sarg., the Helderberg thorn, failed entirely to bear fruit this season, probably because its blossoms were in the right condition to be frozen on the night of June 14th or possibly because it was an "off year." Sometimes thorn trees, like apple trees, appear to have "off years"; that is, a year in which a thorn tree bears an abundant crop of fruit is likely to be followed by one in which it bears no fruit, as if the production of the abundant crop had so weakened its vigor as to render it incapable of bearing two abundant crops in two successive years. The fruitless year is called an "off year."

It is interesting to note the correspondence between the favorable influences of a season on the common products of the garden and field and on the mycological crop of the woods, pastures and waste places. A productive season in one case is usually a productive season in the other. The very fruitful season of 1912 was ushered in by an unusually abundant crop of morels as the following quotations from communications of correspondents will show. "We had a very fair morel season this year and I found about 300." "Mushrooms are very early and very plentiful here this season." "We never had so many or such large morels before." My own experience here in the vicinity of Albany corroborates the above statements. I found morels larger and more plentiful than usual. They seemed to presage an abundantly fruitful season. This prophetic indication has been very satisfactorily fulfilled by an unusually good crop of wild mushroom growths in general; and in August and September the common mushroom, Agaricus campestris L., was very plentiful in pastures in the vicinity of Albany.

Much time has been required and devoted to the necessary preparation for the removal of the herbarium and duplicate specimens from Geological Hall to their new location in the Education Building. The specimens have been securely tied in bundles or, if kept in small boxes, safely packed in larger boxes to facilitate their handling and secure transportation. The contents of the table cases of the anteroom, in anticipation of removal, have for several weeks been packed in boxes and been ready for transportation.

Respectfully submitted
CHARLES H. PECK
State Botanist

Albany, December 31, 1912

PLANTS ADDED TO THE HERBARIUM

New to the herbarium

Achillea ptarmica *L.*
Amanita ovoidea *Bull.*
Anellaria separata (*L.*) *Karst.*
Aposphaeria fibriseda (*C. & E.*)
Artemisia carruthii *Wood*
A. dracunculoides *Pursh*
A. glauca *Poll.*
Arthonia quintaria *Nyl.*
A. radiata (*Pers.*) *Th. Fr.*
Betula alba *L.*
Bolbitius vitellinus (*Pers.*) *Fr.*
Boletus retipes *B. & C.*
Calosphaeria myricae (*C. & E.*)
Calvatia rubroflava (*Cragin*) *Morg.*
Chrysothamnus pinifolius *Greene*
Clavaria grandis *Pk.*
C. vermicularis *Scop.*
Cladochytrium alismatis *Büsgen*
Collema crispum *Borr.*
Collybia murina *Batsch*
Coronopus procumbens *Gilibert*
Crataegus gracilis *S.*
C. harryi *S.*
C. leptopoda *S.*
C. livingstoniana *S.*
C. macera *S.*
C. procera *S.*
Creonectria ochroleuca (*Schw.*)
Diaporthe castaneti *Nits.*
Diatrypella favacea (*Fr.*) *C. & D.*
Didymella asterinoides (*E. & E.*)
Dothidea baccharidis *Cke.*
Escholtzia californica *Cham.*
Flammula graveolens *Pk.*
Helicopsis punctata *Pk.*
Heliomyces pruinosipes *Pk.*
Helminthosporium fuscum *Fckl.*
Hydnum laevigatum *Sw.*
H. subcrinale *Pk.*
Hygrophorus ruber *Pk.*
Inocybe radiata *Pk.*
Lenzites trabea (*Pers.*) *Fr.*
Leptonia euchlora (*Lasch.*) *Fr.*
Macrophoma juniperina *Pk.*
Malus glaucescens *S.*
Mycena flavifolia *Pk.*
M. splendidipes *Pk.*
Opegrapha herpetica *Ach.*
Penicillium hypomycetes *Sacc.*
Pestalozzia truncata *Lev.*
Phialea anomala *Pk.*
Phoma asclepiadea *E. & E.*
P. semiimmersa *Sacc.*
Phyllosticta mahoniaecola *Pass.*
P. rhoicola *E. & E.*
Placodium camptidium *Tuck.*
Pleurotus tessulatus (*Bull.*) *Fr.*
Polyporus dryadeus (*Pers.*) *Fr.*
Puccinia urticae (*Schum.*) *Lagerh.*
Riccardia sinuata (*Dicks.*) *Limpr.*
Russula ballouii *Pk.*
Septoria margaritaceae *Pk.*
Silene dichotoma *Ehrh.*
Tricholoma latum *Pk.*
T. piperatum *Pk.*
T. subpulverulentum (*Pers.*)
Urophlyctis major *Schroet.*
Vermicularia hysteriiformis *Pk.*
Verrucaria muralis *Ach.*
V. papularis *Fr.*
Vicia hirsuta (*L.*) *S. F. Gray*
Zygodesmus avellanus *Sacc.*

Not new to the herbarium

Acetabula vulgaris *Fckl.*
Adiantum pedatum *L.*
Aecidium hydnoideum *B. & C.*
Agaricus abruptibulbus *Pk.*
A. micromegethus *Pk.*
Agrostis borealis *Hart.*
Ajuga reptans *L.*
Aleurodiscus oakesii (*B. & C.*) *Cke.*
Alnus rugosa (*DuRoi*) *Spreng.*
Alopecurus genic. aristulatus *Torr.*

Amanita formosa *G. & R.*
A. frostiana *Pk.*
Amaranthus graecizans *L.*
A. retroflexus *L.*
Ambrosia artemisiifolia *L.*
Andromeda glaucophylla *Link*
Anthemis cotula *L.*
A. tinctoria *L.*
Arenaria stricta *Mx.*
Aristida purpurascens *Poir*
Artemisia biennis *Willd.*
A. frigida *Willd.*
A. gnaphaloides *Nutt.*
A. vulgaris *L.*
Aspidium boottii *Tuck.*
A. cristatum (*L.*) *Sw.*
A. goldianum *Hook.*
A. marginale (*L.*) *Sw.*
A. noveboracensis (*L.*) *Sw.*
A. spinulosum (*O. F. Muell.*)
A. spin. dilatatum (*Hoffm.*)
A. spin. intermedium (*Muhl.*)
A. thelypteris (*L.*) *Sw.*
Asplenium acrostichoides *Sw.*
A. filix-foemina (*L.*)
A. platyneuron (*L.*) *Oakes*
A. trichomanes *L.*
Barbarea vulgaris *R. Br.*
Boletinus grisellus *Pk.*
Boletus brevipes *Pk.*
B. scaber *Fr.*
B. subaur. rubroscriptus *Pk.*
B. subtomentosus *L.*
Botrychium lanceolatum (*S.G.Gmel.*)
B. obliquum *Muhl.*
B. obliq. dissectum (*Spreng.*)
B. ramosum (*Roth*) *Aschers*
B. simplex *E. Hitchc.*
B. tern. intermedium *Eaton*
B. virginianum (*L.*) *Sw.*
Camelina microcarpa *Andrz.*
Camptosorus rhizophyllus (*L.*) *Link*
Cantharellus cibarius *Fr.*
C. floccosus *Schw.*
Carex aestivalis *M. A. Curtis*
C. muhlenbergii *Schkr.*
C. trib. reducta *Bailey*
Carya glabra villosa (*Sarg.*)
C. ovata (*Mill.*) *K. Koch*
Cercospora symplocarpi *Pk.*
Cephalozia lunulaefolia *Dum.*
Chlorosplenium aeruginascens (*Nyl.*)
Cladonia crist. vestita *Tuck.*
C. grac. dilatata (*Hoffm.*)
Clavaria cristata *Holmsk.*
C. fastigiata *L.*
C. kunzei *Fr.*
C. obtusissima minor *Pk.*
C. pinophila *Pk.*
C. stricta *Pers.*
C. tsugina *Pk.*
Clitocybe adirondackensis *Pk.*
C. cerussata *Fr.*
C. maxima *G. & M.*
Clitopilus noveboracensis *Pk.*
Convolvulus sepium pubescens (*Gray*)
Corallorhiza odontorhiza *Nutt.*
Cortinarius uliginosus *Berk.*
C. vernalis *Pk.*
C. variicolor (*Pers.*)
Crucibulum vulgare *Tul.*
Cynanchium nigrum (*L.*) *Pers.*
Cyperus dentatus *Torr.*
C. ferax *Rich.*
Cystopteris bulbifera (*L.*) *Bernh.*
C. fragilis (*L.*) *Bernh.*
Cytospora chrysosperma (*Pers.*) *Fr.*
Daedalea unicolor (*Bull.*) *Fr.*
Dicksonia punctilobula (*Mx.*) *Gray*
Diaporthe parasitica *Murrill*
Doassansia alismatis (*Fr.*) *Cornu*
Elymus canadensis *L.*
Entoloma sericeum (*Bull.*) *Fr.*
E. sinuatum *Fr.*
Epilobium molle *Torr.*
Epipactus repens ophioides (*Fern.*)
E. tesellata (*Lodd.*)
Erigeron annuus (*L.*) *Pers.*
E. canadensis *L.*
Eupatorium pur. maculatum (*L.*)
Equisetum hyemale *L.*
E. scirpoides *Mx.*
E. varieg. nelsonii *Eaton*
Fagus grandiflora *Ehrh.*
Fistulina hepatica *Fr.*
Flammula spum. unicolor *Pk.*
F. sulphurea *Pk.*
Fomes igniarius (*L.*) *Fr.*
F. pinicola (*Sw.*) *Fr.*
Fomitiporia prun. betulicola *Pk.*

Geoglossum microsporum *C. & P.*
Geum canadense *Jacq.*
G. flavum (*Porter*) *Britton*
G. strictum *Ait.*
Grimaldia fragrans (*Balb.*) *Cd.*
Gutierrezia sarothrae (*Pursh*)
Gymnolomia multiflora (*Nutt.*)
Habenaria fimbriata (*Ait.*) *R. Br.*
H. microphylla *Goldie*
Haplosporella ailanthi *E. & E.*
Hebeloma fastibile *Fr.*
Hedeoma pulegioides (*L.*) *Pers.*
Helianthemum majus *BSP.*
Heliopsis scabra *Dunal.*
Helvella capucinoides *Pk.*
Hierochloe odorata (*L.*) *Wahl.*
Humaria leucoloma (*Hedw.*) *Fr.*
H. granulata *Bull.*
Hydnum caput-ursi *Fr.*
Hygrophorus nitidus *B. & C.*
Hypericum perforatum *L.*
Hypholoma incertum *Pk.*
Ilex monticola *Gray*
Inocybe eutheloides *Pk.*
I. geophylla violacea *Pat.*
I. subochracea (*Pk.*) *Mass.*
Jeffersonia diphylla (*L.*) *Pers.*
Jungermannia lanceolata *L.*
Lactarius glyciosmus *Fr.*
L. vellereus *Fr.*
Lamium amplexicaule *L.*
Lecanora subfusca allophana *Ach.*
Lejeunea cavifolia (*Ehrh.*) *Lindb.*
Lenzites sepiaria *Fr.*
Leonorus cardiaca *L.*
Lepiota americana *Pk.*
L. cepaestipes *Sow.*
L. farinosa *Pk.*
L. procera *Scop.*
Liparis loeselii (*L.*) *Rich.*
Listera australis *Lindl.*
Lonicera hirsuta *Eaton*
Lycopodium annotinum *L.*
L. annot. pungens *Desv.*
L. comp. flabelliforme *Fern.*
L. clavatum *L.*
L. inundatum *L.*
L. lucidulum *Mx.*
L. obscurum *L.*
Lycopodium obsc. dendroideum (*Mx.*)
L. tristachyum *Pursh*
Machaeranthera pulverulenta (*Nutt.*)
Malva moschata *L.*
Marasmius elongatipes *Pk.*
M. scorodonius *Fr.*
M. semihirtipes *Pk.*
Marrubium vulgare *L.*
Marsupella emarginata (*Ehrh.*)
Microstylis unifolia (*Mx.*) *BSP.*
Monarda didyma *L.*
Mutinus elegans (*Mont.*) *E. Fisch.*
Myosotis virginica (*L.*) *BSP.*
Nepeta cataria *L.*
Odontoschisma prostratum (*Wahl.*)
Onoclea sensibilis *L.*
Onopordum acanthium *L.*
Origanum vulgare *L.*
Osmunda cinnamomea *L.*
O. claytoniana *L.*
Oxalis filipes *Small*
O. stricta *L.*
Pallavicinia lyellii (*Hook.*)
Panaeolus papilionaceus *Fr.*
Panax quinquefolia *L.*
Panicum boscii *Poir*
P. dichotomum *L.*
P. latifolium *L.*
P. oricola *H. & C.*
P. spretum *Schultes*
P. xanthophysum *Gray*
Panus torulosus *Fr.*
Peridermium pyriforme *Pk.*
P. strobi *Kleb.*
Pertusaria leioplaca (*Ach.*) *Schaer.*
Phallus ravenellii *B. & C.*
Phegopteris dryopteris (*L.*) *Fee*
P. polypodioides *Fee*
Pholiota adiposa *Fr.*
P. autumnalis *Pk.*
P. cerasina *Pk.*
P. duroides *Pk.*
P. squarrosa *Muell.*
Phoma lineolata *Desm.*
Phylloporus rhodoxanthus (*Schw.*)
Physalis virginiana *Mill.*
Picea canadensis (*Mill.*) *BSP.*
Pleurotus ost. magnificus *Pk.*
P. septicus *Fr.*

Pleurotus sulfuroides *Pk.*
Poa debilis *Torr.*
Polygonum acre *HBK.*
P. aviculare *L.*
P. maritimum *L.*
P. pennsylvanicum *L.*
P. persicaria *L.*
Polypodium vulgare *L.*
Polyporus betulinus *Fr.*
P. curtisii *Berk.*
P. distortus *Schw.*
P. frondosus *Fr.*
P. radicatus *Schw.*
P. squamosus (*Huds.*) *Fr.*
P. volvatus *Pk.*
Polystichum acrostichoides (*Mx.*)
P. braunii (*Spenner*) *Fee*
Poria inermis *E. & E.*
Potentilla recta *L.*
Prunella vulgaris *L.*
Psathyrella disseminata *Pers.*
Psilocybe atomatoides *Pk.*
Pteris aquilina *L.*
Ribes triste albinervium (*Mx.*)
Roestelia aurantiaca *Pk.*
Rubus odoratus *L.*
R. triflorus *Richards.*
Russula nigricans (*Bull.*) *Fr.*
R. sanguinea (*Bull.*) *Fr.*
Rynchospora capillacea *Torr.*
Salsola kali tenuifolia *G. F. W. Mey.*
Saponaria officinalis *L.*
Satureja vulgaris (*L.*) *Fritsch*
Scapania undulata (*L.*) *Dum.*
Schistostega osmundacea (*Dicks.*)
Scirpus caespitosus *L.*
S. planifolius *Muhl.*
Scleroderma vulgare *Hornem.*
Seligeria pusilla *B. & S.*
Serapias helleborine *L.*
Sesuvium maritimum (*Walt.*) *BSP.*
Setaria glauca (*L.*) *Bv.*
S. viridis (*L.*) *Bv.*
Shepherdia canadensis (*L.*) *Nutt.*
Sisymbrium offic. leiocarpum *DC.*
Sparganium diver. acaule (*Beebe*)
Spherobolus stellatus *Tode*
Spathularia clavata (*Schaeff.*)
Sphenolobus exsectaeformis (*Briedl.*)
Spiranthes praecox (*Walt.*) *BSP.*
Symphoricarpos orbiculatus *Moench.*
Thlaspi arvense *L.*
Tremella vesicaria *Bull.*
Tricholoma chrysenteroides *Pk.*
Trillium grandiflorum (*Mx.*)
Typhula phacorrhiza *Fr.*
Urnula craterium (*Schw.*) *Fr.*
Valsa pini (*A. & S.*) *Fr.*
Verbascum thapsus *L.*
Verbena hastata *L.*
V. urticaefolia *L.*
Veronica peregrina *L.*
V. tournefortii *C. C. Gmel.*
Vicia angustifolia *Roth*
V. tetrasperma (*L.*) *Moench.*
Viola cucullata *Ait.*
V. septentrionalis *Greene*
Volvaria bombycina (*Pers.*) *Fr.*
Xanthium commune *Britton*
Xyris montana *H. Reis*

CONTRIBUTORS AND THEIR CONTRIBUTIONS

Miss L. C. Allen, Newtonville, Mass.

Clavaria fumigata *Pers.*
Lepiota alleniae *Pk.*

Miss F. Beckwith, Rochester

Artemisia dracunculoides *Pursh*

Mrs N. L. Britton, New York

Schistostega osmundacea (*Dicks.*)
Seligeria pusilla *B. & S.*

Mrs J. C. Cahn, Detroit, Mich.

Clavaria platyclada *Pk.*

Miss V. K. Charles, Washington, D. C.

Agaricus subrufescens *Pk.*

Mrs E. P. Gardner, Canandaigua

Ajuga reptans *L.*
Convolvulus sepium pubescens (*Gray*)
Corallorhiza odontorhiza *Nutt.*
Geum flavum (*Porter*) *Britton*
Heliopsis scabra *Dunal.*
Panicum boscii *Poir*
P. spretum *Schultes*
Physalis virginiana *Mill.*
Veronica peregrina *L.*
V. tournefortii *C. C. Gmel.*

Mrs L. L. Goodrich, Syracuse

Crucibulum vulgare *Tul.*

Miss C. C. Haynes, New York

Bazzania tricrenata (*Wahl.*) *Trev.*
B. trilobata (*L.*) *S. F. Gray*
Blepharostoma trichophyllum (*L.*)
Calypogeia trichomanis (*L.*) *Cd.*
Cephalozia bicuspidata (*L.*) *Dum.*
C. connivens (*Dicks.*)
C. fluitans (*Nees*) *Spruce*
C. lunulaefolia *Dum.*
Chiloscyphus polyanthus (*L.*) *Cd.*
Conocephalum conicum *L.*
Diplophylleia taxifolia (*Wahl.*)
Frullania eboracensis *Gottsche*
Geocalyx graveolens (*Schrad.*)
Jungermannia lanceolata *L.*
Lejeunea cavifolia (*Ehrh.*) *Lindb.*
Lepidozia setacea (*Web.*) *Mitt.*
Lophocolea heterophylla (*Schrad.*)
Lophozia alpestris (*Schleich.*)
Lophozia attenuata (*Mart.*) *Dum.*
L. barbata (*Schreb.*) *Dum.*
L. mildeana (*Gottsche*)
Marchantia polymorpha *L.*
Marsupella emarginata (*Ehrh.*)
Mylia anomala (*Hook.*) *S. F. Gray*
M. taylori (*Hook.*) *S. F. Gray*
Nardia crenulata (*Smith*) *Lindb.*
Notothylas orbicularis (*Schw.*)
Odontoschisma denudatum (*Mart.*)
O. prostratum (*Sw.*)
Pallavicinia lyellii (*Hook.*)
Pellia epiphylla (*L.*) *Cd.*
Plagiochila asplenioides (*L.*) *Dum.*
Radula tenax *Lindb.*
Reboulia hemisphaerica (*L.*) *Raddi*
Riccardia sinuata (*Dicks.*) *Limpr.*
Ricciella sullivantii (*Aust.*)

Scapania apiculata *Spruce*
S. nemorosa (*L.*) *Dum.*
S. undulata (*L.*) *Dum.*
Sphenolobus exsectaeformis (*Briedl.*)
S. exsectus (*Schmid.*)
Temnoma setiforme (*Ehrh.*)
Trichocolea tomentella (*Ehrh.*) *Dum.*

Miss A. Hibbard, West Roxbury, Mass.

Clavaria obtusissima *Pk.*
Clavaria subcaespitosa *Pk.*
Tricholoma piperatum *Pk.*

Mrs M. W. Hill, St Paul, Minn.

Lentinus tigrinus (*Bull.*) *Fr.*

Miss M. F. Miller, Washington, D. C.

Adiantum pedatum *L.*
Aspidium boottii *Tuck.*
A. cristatum (*L.*) *Sw.*
A. goldianum *Hook.*
A. marginale (*L.*) *Sw.*
A. noveboracense (*L.*) *Sw.*
A. spinulosum (*O. F. Muell.*)
A. spin. dilatatum (*Hoffm.*)
A. spin. intermedium (*Muhl.*)
A. thelypteris (*L.*) *Sw.*
Asplenium acrostichoides *Sw.*
A. filix-foemina (*L.*)
A. platyneuron (*L.*) *Oakes*
A. trichomanes *L.*
Botrychium lanceolatum (*S. G. Gmel.*)
B. obliquum *Muhl.*
B. obliq. dissectum (*Spreng.*)
B. ramosum (*Roth*)
B. simplex *E. Hitckc.*
tern. intermedium *Eaton*
B. virginianum (*L.*) *Sw.*
Camptosorus rhizophyllus (*L.*) *Link*
Cystopteris bulbifera (*L.*) *Bernh.*
C. fragilis (*L.*) *Bernh.*
Dicksonia punctilobula (*Mx.*) *Gray*
Equisetum hyemale *L.*
Geum canadense *Jacq.*
Lycopodium annotinum *L.*
L. annot. pungens *Desv.*
L. clavatum *L.*
L. comp. flabelliforme *Fern.*
L. lucidulum *Mx.*
L. obscurum *L.*
L. obsc. dendroideum (*Mx.*)
L. tristachyum *Pursh*
Microstylis unifolia (*Mx.*) *BSP.*
Monarda didyma *L.*
Onoclea sensibilis *L.*
Osmunda cinnamomea *L.*
O. claytoniana *L.*
Panax quinquefolia *L.*
Phegopteris dryopteris (*L.*) *Fee*
P. polypodioides *Fee*
Polypodium vulgare *L.*
Polystichum acrostochoides (*Mx.*)
P. braunii (*Spenner*) *Fee*
Potentilla recta *L.*
Pteris aquilina *L.*

Mrs E. Watrous, Hague

Arenaria stricta *Mx.*

Miss E. C. Webster, Canandaigua

Camelina microcarpa *Andrz.*
Cortinarius variicolor (*Pers.*)
Lamium amplexicaule *L.*
Lepiota farinosa *Pk.*
Thlaspi arvense *L.*

Mrs M. S. Whetstone, Minneapolis, Minn.

Boletus sphaerosporus *Pk.*
Entoloma helodes *Fr.*
Guepinia elegans *B. & C.*
Guepiniopsis fissus *Berk.*
Inocybe fibrillosa *Pk.*
Marasmius trullisatipes *Pk.*
Pholiota autumnalis *Pk.*
Psilocybe cystidiosa *Pk.*
Stropharia umbilicata *Pk.*
Volvaria perplexa *Pk.*

W. E. Abbs, Rochester

Boletus subaur. rubroscriptus *Pk.*
Phylloporus rhodoxanthus (*Schw.*)
Tricholoma subpulverulentum (*Pers.*) *Fr.*

C. P. Alexander, Gloversville

Achillea ptarmica *L.*
Andromeda glaucophylla *Link*
Carex aestivalis *M. A. Curtis*
C. muhlenbergii *Schkr.*
C. tribul. reducta *Bailey*
Cyperus dentatus *Torr.*
Epilobium molle *Torr.*
Epipactis repens ophioides (*Fern.*)
E. tesellata (*Lodd.*)
Equisetum scirpoides *Mx.*
E. varieg. nelsonii *Eaton*
Habenaria fimbriata (*Ait.*) *R.Br.*
Habenaria microphylla *Goldie*
Helianthemum majus *BSP.*
Ilex monticola *Gray*
Liparis loeselii (*L.*) *Rich.*
Listera australis *Lindl.*
Lycopodium inundatum *L.*
Microstylis uniflora (*Mx.*) *BSP.*
Panicum oricola *H. & C.*
P. xanthophysum *Gray*
Shepherdia canadensis (*L.*) *Nutt.*
Sparganium diver. acaule (*Beebe*)
Xyris montana *H. Reis*

F. H. Ames, Brooklyn

Boletus scaber *Fr.*
Polyporus curtisii *Berk.*

G. F. Atkinson, Ithaca

Cladochytrium alismatis *Büsgen*
Clavaria tetragona *Schw.*
Doassansia alismatis (*Fr.*) *Cornu*
Heliomyces pruinosipes *Pk.*
Lepiota cepaestipes *Sow.*
Marasmius semihirtipes *Pk.*
Tremellodendron aurantium *Atk.*
Urophlyctis major *Schroet.*

G. G. Atwood, Albany

Diaporthe parasitica *Murrill*
Peridermium strobi *Kleb.*

W. H. Ballou, New York

Lactarius volem. subrugosus *Pk.*
Lenzites trabea (*Pers.*) *Fr.*
Mycena splendidipes *Pk.*
Phallus ravenellii *B. & C.*
Psilocybe graveolens *Pk.*
Russula ballouii *Pk.*

H. J. Banker, Greencastle, Ind.

Helvella capucinoides *Pk.*
Polyporus distortus *Schw.*
Volvaria bombycina (*Pers.*) *Fr.*

E. Bartholomew, Stockton, Kan.

Asteromella asteris *Pk.*
Coryneum effusum *Pk.*
Cylindrosporium crescentum *Barth.*
Diatrype albopruinosa (*Schw.*) *Cke.*

Fusicladium depressum (*B. & Br.*)
Herpotrichia diffusa (*Schw.*) *Sacc.*
Hysteriographium acerinum *Pk.*
Irpex cinnamomeus *Fr.*
Ramularia anomala *Pk.*
Valsa translucens (*DeNot.*)
Valsa truncata *C. & P.*

M. S. Baxter, Rochester

Alopecurus genic. aristulatus *Torr.*
Artemisia biennis *Willd.*
A. carruthii *Wood*
A. dracunculoides *Pursh*
A. frigida *Willd.*
A. glauca *Pall.*
A. gnaphalodes *Nutt.*
A. vulgaris *L.*
Carex brunnescens *Poir*
C. flava *L.*
C. lanuginosa *Mx.*
C. leptalea *Wahl.*
Chrysothamnus pinifolius *Greene*
Cynosurus cristatus *L.*
Eleocharis rostellata *Torr.*
Elymus canadensis *L.*
Grindelia squarrosa (*Pursh*) *Dunal.*
Gutierrezia sarothrae (*Pursh*)
Gymnolomia multiflora (*Nutt.*)
Hierochloe odorata (*L.*) *Wahl.*
Jeffersonia diphylla (*L.*) *Pers.*
Machaeranthera pulverulenta (*Nutt.*)
Marrubium vulgare *L.*
Panicum dichotomum *L.*
P. latifolium *L.*
P. spretum *Schultes*
Poa debilis *Torr.*
Rynchospora capillacea *Torr.*
Scirpus caespitosus *L.*
S. planifolius *Muhl.*
Serapias helleborine *L.*

F. S. Boughton, Pittsford

Acetabula vulgaris *Fckl.*
Boletinus grisellus *Pk.*
Clavaria fastigiata *L.*
C. pinophila *Pk.*
C. stricta *Pers.*
C. vermicularis *Scop.*
Inocybe geophylla violacea *Pat.*
Panus torulosus *Fr.*
Pleurotus tessulatus (*Bull.*) *Fr.*
Psilocybe atomatoides *Pk.*
Russula sanguinea (*Bull.*) *Fr.*
Urnula craterium (*Schw.*) *Fr.*

F. J. Braendle, Washington, D. C.

Hydnum fasciatum *Pk.*
Hygrophorus nemoreus *Fr.*
Polystictus perg. revolutus *Pk.*
Polystictus pseudopergamenus (*Thuem.*)
Pterula densissima *B. & C.*
Tricholoma tumulosum *Kalchb.*

C. K. Brain, Columbus, Ohio

Collybia delicatula *Pk.*
Collybia murina *Batsch*
Russula xerampelina *Fr.*

S. H. Burnham, Hudson Falls

Aleurodiscus oakesii (*B. & C.*)
Amaranthus retroflexus *L.*
Ambrosia artemisiifolia *L.*
Anthemis cotula *L.*
Barbarea vulgaris *R. Br.*
Boletus retipes *B. & C.*
Cantharellus cibarius *Fr.*
Cercospora symplocarpi *Pk.*
Clavaria cristata *Holmsk.*
C. grandis *Pk.*
C. kunzei *Fr.*
C. tsugina *Pk.*
C. vermicularis *Scop.*
Clitocybe adirondackensis *Pk.*
C. cerussata *Fr.*
C. maxima *G. & M.*

Clitopilus noveboracensis *Pk.*
Collema crispum *Borr.*
Collybia murina *Batsch*
Cortinarius vernalis *Pk.*
Daedalea unicolor (*Bull.*) *Fr.*
Diatrypella favacea (*Fr.*)
Entoloma sericeum (*Bull.*) *Fr.*
E. sinuatum *Fr.*
Erigeron annuus (*L.*) *Pers.*
E. canadensis *L.*
Fagus grandiflora *Ehrh.*
Flammula graveolens *Pk.*
Fomes igniarius (*L.*) *Fr.*
Geoglossum microsporum *C. & P.*
Geum strictum *Ait.*
Grimaldia fragrans (*Balb.*) *Cd.*
Haplosporella ailanthi *E. & E.*
Hedeoma pulegioides (*L.*) *Pers.*
Heliomyces pruinosipes *Pk.*
Hydnum laevigatum *Sw.*
Hygrophorus nitidus *B. & C.*
H. ruber *Pk.*
Hypericum perforatum *L.*
Inocybe eutheloides *Pk.*
I. radiata *Pk.*
I. subochracea (*Pk.*) *Mass.*
Lactarius vellereus *Fr.*
Leonurus cardiaca *L.*
Malva moschata *L.*
Marasmius elongatipes *Pk.*
M. scorodonius *Fr.*
Mutinus elegans (*Mont.*) *E. Fisch.*
Myosotis virginica (*L.*) *BSP.*
Nepeta cataria *L.*
Origanum vulgare *L.*
Oxalis filipes *Small*
O. stricta *L.*
Pestalozzia truncata *Lev.*
Pholiota autumnalis *Pk.*
P. squarrosa *Muell.*
Phoma lineolata *Desm.*
Pleurotus ost. magnificus *Pk.*
Pleurotus sulfuroides *Pk.*
Polygonum acre *HBK.*
P. aviculare *L.*
P. pennsylvanicum *L.*
P. persicaria *L.*
Polyporus frondosus *Fr.*
P. radicatus *Schw.*
Prunella vulgaris *L.*
Psathyrella disseminata *Pers.*
Ribes triste albinervium (*Mx.*)
Rubus odoratus *L.*
Salsola kali tenuifolia *G. F. W. Mey.*
Saponaria officinalis *L.*
Satureja vulgaris (*L.*) *Fritsch*
Setaria glauca (*L.*) *Bv.*
S. viridis (*L.*) *Bv.*
Sisymbrium offic. leiocarpum *DC.*
Spathularia clavata (*Schaeff.*)
Sphaerobolus stellatus *Tode*
Symphoricarpos orbiculatus *Moench*
Tremella vesicaria *Bull.*
Tricholoma chrysenteroides *Pk.*
T. latum *Pk.*
Typhula phacorrhiza *Fr.*
Verbascum thapsus *L.*
Verbena hastata *L.*
V. urticaefolia *L.*
Verrucaria muralis *Ach.*
V. papularis *Fr.*
Viola cucullata *Ait.*
V. septentrionalis *Greene*
Xanthium commune *Britton*

M. T. Cook, New Brunswick, N. J.

Polycephalum subauranticum *Pk.*

S. Davis, Brookline, Mass.

Bulgaria rufa *Schw.*
Clavaria kromholzii *Fr.*
Clitopilus leptonia *Pk.*
Entoloma flavifolium *Pk.*
E. fumosonigrum *Pk.*
E. minus *Pk.*
E. modestum *Pk.*
Inocybe asterospora *Quel.*
I. castaneoides *Pk.*
Inocybe decipientoides *Pk.*
I. diminuta *Pk.*
I. longispora *Pk.*
I. teichospora *Berk.*
Lepiota cristatella *Pk.*
Morchella conica *Pers.*
M. esculenta (*L.*) *Pers.*
Nolanea delicatula *Pk.*
N. multiformis *Pk.*
Ombrophila clavus (*A. & S.*) *Cke.*

J. Dearness, London, Ont.

Aecidium magnatum *Arth.*
A. monoicum *Pk.*
Diplodia exocarpi *Dearness*
Pestalozzia fun. multiseta *Sacc.*
Ramularia pruni *Pk.*
Septogloeum salicinum (*Pk.*) *Sacc.*
Uromyces trifolii (*Hedw.*) *Lev.*

C. C. DeRouville, Albany

Agaricus micromegathus *Pk.*
Amanita formosa *G. & R.*

F. Dobbin, Shushan

Phialea subcarnea (*C. & P.*)
Picea canadensis (*Mill.*) *BSP.*
Ptilidium ciliare (*L.*) *Nees*
Vicia angustifolia *Roth*
Vicia tetrasperma (*L.*) *Moench*

J. Dunbar, Rochester

Malus glaucescens *S.*

D. L. Dutton, Brandon, Vt.

Physcia ciliaris (*L.*) *Ach.*
Stereocaulon coralloides *Fr.*

C. E. Fairman, Lyndonville

Aposphaeria fibriseda (*C. & E.*)
Didymella asterinoides (*E. & E.*)
Helicopsis punctata *Pk.*
Helminthosporium fuscum *Fckl.*
Humaria leucoloma (*Hedw.*) *Fr.*
Hydnum subcrinale *Pk.*
Pholiota duroides *Pk.*
Phyllosticta mahoniaecola *Pass.*
Zygodesmus avellaneus *Sacc.*

W. G. Farlow, Cambridge, Mass.

Puccinia physostegiae *Pk. & Clint.*

J. C. Fisher, Baltimore, Md.

Claviceps purpurea (*Fr.*) *Tul.*

W. P. Fraser, Quebec, Que.

Diatrype tumidella *Pk.*

H. Garman, Lexington, Ky.

Aspergillus clavellus *Pk.*
Sporotrichum atropurpureum *Pk.*

A. O. Garrett, Salt Lake City, Utah

Albugo bliti (*Biv.*) *Ktze.*
A. candida (*Pers.*) *Ktze.*
A. tragopoginis (*DC.*) *Gray*
Cercosporella fraserae (*E. & E.*)
Claviceps setulosa (*Oud.*) *Sacc.*
Clavaria contorta *Holmsk.*
Cylindrosporium padi *Karst.*
Erysiphe polygoni *DC.*
Lophiostoma sieversiae *Pk.*
Microsphaera alni ludens *Salm.*
Monilia sidalceae *Pk.*
Ramularia sambucina *Sacc.*
Rhysotheca halstedii (*Farl.*)
Septoria polemonioides *Pk.*
Tuberculina persicina (*Ditm.*) *Sacc.*

W. E. Geiser, Albany
Amanita ovoidea *Bull.*

H. T. Güssow, Ottawa, Que.
Pleurotus petaloides (*Bull.*) *Fr.*

M. E. Hard, Kirkwood, Mo.
Collybia atrata *Fr.*

L. R. Hesler, Ithaca
Sphaerella saccharoides *Pk.* Valsa pini (*A. & S.*) *Fr.*

G. H. Hudson, Plattsburg
Chlorosplenium aeruginascens (*Nyl.*) *Karst.*

F. W. Kelley, Albany
Trillium grandiflorum (*Mx.*) *Salisb.*

G. L. Kirk, Rutland, Vt.
Endocarpiscum guepini (*Delis*) *Nyl.*

R. H. Kirtland, Albany
Lactarius glyciosmus *Fr.* Russula nigricans (*Bull.*) *Fr.*

L. C. C. Krieger, Chico, Cal.
Bolbitius vitellinus (*Pers.*) *Fr.* Lysurus borealis (*Burt*) *C. G. Lloyd*

R. Latham, Orient Point

Anthemis tinctoria *L.*
Aristida purpurascens *Poir*
Arthonia quintaria *Ach.*
Calosphaeria myricae (*C. & E.*)
Calvatia rubroflava (*Cragin*)
Cladonia crist. vestita *Tuck.*
C. grac. dilitata (*Hoffm.*)
Cyperus ferax *Rich.*
Dothidea baccharidis *Cke.*
Humaria granulata *Bull.*
Lecanora subfusca allophana *Ach.*
Lenzites sepiaria *Fr.*
L. trabea (*Pers.*) *Fr.*
Macrophoma juniperina *Pk.*
Odontoschisma prostratum (*Wahl.*)
Onopordum acanthium *L.*
Opegrapha herpetica *Ach.*
Pertusaria leioplaca (*Ach.*) *Schaer.*
Phoma asclepiadea *E. & E.*
P. semiimmersa *Sacc.*
Phyllosticta rhoicola *E. & E.*
Placodium camptidium *Tuck.*
Pleurotus septicus *Fr.*
Polygonum maritimum *L.*
Poria inermis *E. & E.*
Scleroderma vulgare *Hornem.*
Sesuvium maritimum (*Walt.*) *BSP.*
Spiranthes praecox (*Walt.*) *W. & C.*
Tricholoma piperatum *Pk.*

C. G. Lloyd, Cincinnati, Ohio
Polyporus dryadeus (*Pers.*) *Fr.*

C. A. Mabie, Holley
Hydnum caput-ursi *Fr.* Lepiota americana *Pk.*

R. B. Mackintosh, Peabody, Mass.
Hypholoma velutinum leucocephalum *B. & Br.*

G. E. Morris, Waltham, Mass.
Boletinus glandulosus *Pk.*
B. solidipes *Pk.*
Boletus rubinellus *Pk.*
B. satanus *Lenz*
Clavaria ligula *Fr.*
Eccilia regularis *Pk.*
Flammula brunneodisca *Pk.*
F. sphagnicola *Pk.*
Hydnum geogenium *Fr.*
Lenzites sepiaria *Fr.*
Leptonia euchlora (*Lasch.*) *Fr.*

W. A. Murrill, New York
Hypholoma ambiguum *Pk.*

H. S. Paine, Glens Falls
Amanita frostiana *Pk.*
Cantharellus floccosus *Schw.*

F. T. Pember, Granville
Prunella vulgaris *L.*

A. J. Perkins, Santa Ana, Cal.
Gyrophragmium decipiens *Pk.*

C. R. Pettis, Albany
Peridermium pyriforme *Pk.*

F. J. Seaver, New York
Creonectria ochroleuca (*Schw.*) *Seaver*

W. L. Sherwood, New York
Selaginella sherwoodii *Underw.*

F. C. Stewart, Geneva
Flammula sulphurea *Pk.*
Fomes pinicola (*Sw.*) *Fr.*
Hebeloma fastibile *Fr.*
Panaeolus papilionaceus *Fr.*
Pholiota adiposa *Fr.*
P. cerasina *Pk.*

D. R. Sumstine, Wilkinsburg, Pa.
Diaporthe castaneti *Nits.*
Diaporthe parasitica *Murrill*

D. B. Swingle, Bozeman, Mont.
Trametes malicola *B. & C.*

W. H. VanGasbeck, Albany
Carya ovata (*Mill.*) *K. Koch*

J. M. VanHook, Bloomington, Ind.
Rosellinia mammiformis (*Pers.*) *Ces. & DeNot.*

H. L. Wells, New Haven, Conn.

Boletus edulis clavipes *Pk.*
Boletus gertrudiae *Pk.*

M. S. Wheeler, Berlin, Mass.

Diaporthe parasitica *Murrill*

T. E. Wilcox, Washington, D. C.

Armillaria nardosmia *Ellis*
Boletus auriporus *Pk.*
Boletus subluteus *Pk.*
Calvatia craniiformis (*Schw.*)
Tricholoma equestre (*L.*) *Fr.*

F. A. Wolf, Auburn, Ala.

Pestalozzia rostrata *Zab.*

D. B. Young, Albany

Crucibulum vulgare *Tul.*
Lepiota farinosa *Pk.*
Penicillium hypomycetis *Sacc.*
Polyporus squamosus (*Huds.*) *Fr.*
P. volvatus *Pk.*
Roestelia aurantiaca *Pk.*

SPECIES NOT BEFORE REPORTED

Achillea ptarmica L.

Near Gloversville, Fulton co. C. P. Alexander. Introduced and probably escaped from cultivation.

Amanita ovoidea Bull.

Ground in woods. Near Hurstville, Albany co. September. W. B. Geiser. The description of this species will be found in the chapter on Edible fungi in this report.

Anellaria separata (L.) Karst.

On manure in groves. North Elba, Essex co. July.

Aposphaeria fibriseda (C. & E.) Sacc.

Decorticated wood of sumac. Lyndonville, Orleans co. May. C. E. Fairman.

Artemisia carruthii Wood

Cobbs Hill reservoir. Rochester. September. M. S. Baxter.

Artemisia dracunculoides Pursh

Cobbs Hill reservoir. Rochester. October. Miss Florence Beckwith. M. S. Baxter. Introduced but apparently well established.

Artemisia glauca Pall.

Cobbs Hill reservoir. Rochester. September. M. S. Baxter.

Arthonia quintaria Nyl.

On bark of Ailanthus, Ailanthus glandulosa Desf. and butternut, Juglans cinerea L. Orient Point, Suffolk co. June. R. Latham. Shushan, Washington co. August. F. Dobbin.

Arthonia radiata (Pers.) Th. Fr.

On bark of shag-bark hickory, Carya ovata (Mill.) K. Koch and basswood, Tilia americana L. Shushan. August. F. Dobbin. Determined by G. K. Merrill.

Betula alba L.

The European white birch is often planted for ornament in parks and lawns. Near Rochester it has escaped from cultivation and is apparently permanently established in a wild locality not far from the city.

Bolbitius vitellinus (Pers.) Fr.

Manure in groves. North Elba. July.

Boletus retipes B. & C.

Woods. Vaughns, Washington co. September. S. H. Burnham. This is a southern species and the locality here given is probably near the northern limit of its range.

Calosphaeria myricae (C. & E.) E. & E.

Dead stems and branches of bayberry, Myrica carolinensis Mill. Orient point. December and January. R. Latham.

Calvatia rubroflava (Cragin) Morg.

Sandy soil. Orient Point. November. R. Latham.

Chrysothamnus pinifolius Greene

Cobbs Hill reservoir. Rochester. September. M. S. Baxter. Determined by P. A. Rydberg.

Clavaria grandis Pk.

Woods. Vaughns. October. S. H. Burnham. This is a small slender form with few short branches supported by a long slender stem.

Clavaria vermicularis Scop.

Ray Brook, Essex co. C. H. Peck. Vaughns. October. S. H. Burnham. Pittsford, Monroe co. September. F. S. Boughton.

Cladochytrium alismatis Büsgen

Living and languishing leaves of water plantain, Alisma plantagoaquatica L. Ithaca flats. July. B. B. Higgins. Communicated by G. F. Atkinson.

Collema crispum Borr.

On mosses. Vaughns. April. S. H. Burnham.

Collybia murina Batsch

Among fallen leaves in woods. North Elba. July. C. H. Peck. Vaughns. August. S. H. Burnham.

Coronopus procumbens Gilibert

Near Chenango lake, Chenango co. F. V. Coville. Introduced. The specimens are apparently a dwarf form without fruit.

Crataegus gracilipes S.

East side of Hemlock lake, Ontario co. September.

Crataegus harryi S.

Wetstone brook near Honeoye state road, Richmond, Ontario co. September.

Crataegus leptopoda S.

East side of Hemlock lake. September.

Crataegus livingstoniana S.

East side of Hemlock lake near the north end. September.

Crataegus macera S.

East side of Hemlock lake near the north end. September.

Crataegus procera S.

East side of Hemlock lake near the north end. September.

Creonectria ochroleuca (Schw.) Seaver

On white birch. Autumn. New York City. F. J. Seaver. Sphaeria ochroleuca Schw., Nectria ochroleuca Berk., Nectria aureofulva C. & E., Nectria pallida E. & E. and Nectria depauperata Cke. are regarded as synonyms of this species by Mr Seaver.

Diaporthe castaneti Nits.

Dead branches of chestnut, Castanea dentata (Marsh.) Borkh. Bemus Point, Chautauqua co. May. D. R. Sumstine.

Diatrypella favacea (Fr.) Ces. & DeNot.

Dead branches of European white birch, Betula alba L. Albany. April. S. H. Burnham.

Didymella asterinoides (E. & E.) Rehm

Dead stems of wild teasel, Dipsacus sylvestris Huds. Lyndonville. May. C. E. Fairman. This is Sphaerella asterinoides E. & E.

Dothidea baccharidis Cke.

Dead branches of groundsel bush, Baccharis halimifolia L. Orient Point. April. R. Latham.

Escholtzia californica Cham.

Cobbs Hill reservoir. Rochester. September. This is commonly called California poppy. It is abundant on the steep banks of the reservoir and is apparently well and permanently established.

Flammula graveolens Pk.

Forbes Manor grounds in old sawdust. Rensselaer. November. S. H. Burnham.

Helicopsis punctata n. sp.

Cespitose; tufts gregarious, minute, .25–.5 mm broad, brown; hyphae very short or obsolete, irregular, slender, hyaline; spores convolute, forming a spiral, 6–8-septate, usually with a nucleus in each cell, colored, persistent, 4–5 μ broad.

Inside of bark scales of some species of Prunus. April. Lyndonville. C. E. Fairman.

Caespites gregarii, minuti, .25–.5 mm lati, brunnei; hyphae brevissimae vel obsoletae, irregulares, graciles, hyalinae; sporae convolutae, spiram 6–8-septatem, 4–5 μ latam, coloratam, persistentem, cellis uninucleatis, formantes.

Heliomyces pruinosipes n. sp.

Pileus tremelloid, thin, submembranaceous, broadly convex or depressed by the upcurving of the margin, glabrous, hygrophanous, bright orange red when moist, reddish brown when dry, odor strong, disagreeable; lamellae thin, narrow, close, adnate, pallid; stems slender, hollow, dark reddish brown, usually pruinose or slightly pubescent above, whitish tomentose at the base and there fasciculately united; spores not seen.

Pileus 1–2 cm broad; stem 2–3 cm long, 1.2–2.5 mm thick.

Around old stumps of coniferous trees. Vaughns. August and September. S. H. Burnham. On bark. Ithaca. September. G. F. Atkinson.

Pileus tremelloideus, tenuis, submembranaceous, late convexus vel depressus, margine recurvo, glaber, hygrophanous, humidus laete aurantiaco-ruber, siccus, rubescente brunneus, odore graveolente, ingrato; lamellae tenues, angustae, confertae, adnatae, pallidae; stipites graciles, cavi, rufescente brunnei, vulgo pruinosi vel leviter apice pubescentes, basi albescente tomentosi, fasciculati; sporae ignotae.

Helminthosporium fuscum Fckl.

Dead herbaceous stems. Lyndonville. April. C. E. Fairman.

Hydnum laevigatum Sw.

Near Tripoli, Washington co. October. S. H. Burnham.

Hydnum subcrinale n. sp.

Subiculum effused, composed of a whitish tomentum; aculei very slender, close, equal or slightly tapering upward, flexuous, subglabrous, acute, pallid or subincarnate; spores minute, subglobose, 1.5–2 μ broad.

Decayed wood. Blue Mountain lake, Hamilton co. August. C. E. Fairman. This resembles Hydnum crinale Fr. in structure but is very unlike it in color.

Subiculum effusum, tomento albido compositum; aculei gracillimi, conferti, aequales vel sursum leviter attenuati, flexuosi, subglabri, acuti, pallidi vel subincarnati; sporae minutae, subglobose, 1.5–2 μ latae.

Hygrophorus ruber Pk.

Woods. Vaughns. Fine large bright colored specimens were collected in September by S. H. Burnham.

Inocybe radiata Pk.

Under pine trees. Vaughns. October. S. H. Burnham. The epidermis of this species sometimes excoriates as in Inocybe excoriata Pk. The specimens referred to this species in New York State Museum Bulletin 105, page 24, as a small form belong to I. asterospora Quel.

Lenzites trabea (Pers.) Fr.

On pine wood. Richmond co. November. W. H. Ballou. Orient Point. R. Latham.

Leptonia euchlora (Lasch.) Fr.

Orville, Onondaga co. August. G. E. Morris.

Macrophoma juniperina n. sp.

Perithecia gregarious, .3–.5 mm broad, thin, slightly prominent, at first covered by the epidermis, then erumpent, black, white within; spores elliptic, oblong or obovate, hyaline, granulose within, 25–40 x 12–18 μ, sporophores mostly shorter than the spores.

Dead branchlets of red cedar, Juniperus virginiana L. Orient Point. December. R. Latham.

The spores are similar in size to those of Macrophoma cavarae Poll., but they are more variable in shape and are not nucleate.

Perithecia gregaria, .3–.5 mm lata, tenua, leviter prominentia, primum epidermide tecta, demum erumpentia, atra, intra alba; sporae ellipsoideae, oblongae vel obovatae, hyalinae, intra granulosae, 25–40 x 12–18 μ, sporophores vulgo sporis breviores.

Malus glaucescens S.

Near Charlotte, Monroe co. September. J. Dunbar.

Mycena flavifolia n. sp.

Pileus thin, slightly submembranaceous, conic or convex, sulcate striate, somewhat plicate-crenate on the margin, glabrous, pale smoky yellow, becoming pale pinkish brown or subalutaceous in drying, sometimes slightly umbonate; lamellae thin, close, broad at the outer extremity, narrowed toward the stem, pale yellow, becoming pallid in drying; stem slender, equal, glabrous, hollow, chestnut colored; spores ellipsoid or subovoid, 6–8 x 4–5 μ.

Gregarious. Under balsam fir trees. North Elba. September. The center of the pileus is often more highly colored than the rest.

Pileus tenuis, submembranaceous, sublentus, conicus vel convexus, sulcato–striatus, interdum margine plicato–crenatus, glaber, subumbonatus, pallide fumoso-luteus, in siccitate incarnato-brunnescens vel subalutaceus; lamellae tenues, confertae, anteriore latae, posteriore angustatae, pallido luteae, pallescentes; stipes gracilis, aequalis, glaber, cavus, castaneus; sporae ellipsoideae vel subovoideae 6–8 x 4–5 μ.

Mycena splendidipes n. sp.

Plate X

Pileus thin, submembranaceous, oval when young, brown above and yellow below, becoming grayish green, greenish brown or

brown and subcampanulate or convex with age, striate, glabrous, odor strong, flavor disagreeable, properties poisonous; lamellae subdistant, rather narrow, adnate, white or whitish; stem long or short, straight or flexuous, hollow, glabrous, bright lemon yellow; spores broadly ellipsoid or subglobose, 6–8 x 4–6 μ.

Pileus 10–20 mm broad; stem 5–30 cm long, 1–2 mm thick.

Decaying pine leaves. Richmond co. November. W. H. Ballou.

This is a dangerous or poisonous species. A single plant chewed and possibly a little of it swallowed caused sickness for some time.

Pileus tenuis, submembraneus, primum ovalis superiore brunneus, inferiore luteus, demum griseo-viridis, straitus, convexus subcampanulatusve, glaber, graveolens, flavor ingratus, venenus; lamellae subdistantes, angustae adnatae, albae albidaeve; stipes longus brevisve, rectus flexuosuve, cavus, glaber, luteus; sporae late ellipsoideae vel subglobosae, 6–8 x 4–6 μ.

Opegrapha herpetica Ach.

On basswood, Tilia americàna L. Orient Point. June. R. Latham. Determined by G. K. Merrill who says of it, "the first American specimen I have seen."

Penicillium hypomycetes Sacc.

On the inner bark of an unknown tree. Albany. March. D. B. Young.

Pestalozzia truncata Lev.

On cone scales of Norway spruce, Picea excelsa Link. Albany. April. S. H. Burnham. The name of this species is suggested by the fact that in old spores the terminal hyaline cells fall away leaving the colored central part with truncate ends.

Phialea anomala n. sp.

Receptacle thin, broadly cupulate or disciform, 1.5–3 mm broad, externally clothed with small, tawny, radiating fibrils, the margin incurved, entire; stem slender, firm, flexuous, .5–1.5 cm long, tawny, fibrillose, tomentose, fulvous; hymenium greenish black; asci cylindric or subclavate, eight-spored, spores ellipsoid or somewhat narrowed toward the base, continuous, hyaline, 10–12 x 4–5 μ, paraphyses filiform.

On dead herbaceous stems or twigs in wet places. Remsen, Oneida co. August.

The anomalous character of this species is in its tawny, fibrillose stem and the exterior surface of the receptacle. The peculiar color of the hymenium is also unusual in this genus.

Receptaculum tenue, late cupulatum vel disciforme, 1.5–3 mm latum, fibris parvis fulvis radiantibus externe investum, margine incurvo, integrum; stipes gracilis, fulvus, fibrilloso-tomentosus, firmus, flexuosus, .5–1.5 cm longus; hymenium viride atrum; asci cylindracei subclavative, 8-sporae ellipsoideae vel basi leviter attenuatae, continuae, hyalinae, 10–12 x 4–5 μ, paraphyses filiformes.

Phoma asclepiadea E. & E.

Dead stems of common milkweed, Asclepias syriaca L. Orient Point. January. R. Latham.

Phoma semiimmersa Sacc.

Dead branches of thorn bushes. Orient Point. January. R. Latham.

Phyllosticta mahoniaecola Pass.

Leaves of the so-called cultivated "American holly," a species of Mahonia. Lyndonville. September. C. E. Fairman.

Phyllosticta rhoicola E. & E.

Living leaves of poison ivy, Rhus toxicodendron L. Orient Point. August. R. Latham.

Placodium camptidium Tuck.

Oak bark. Orient Point. November. R. Latham. Determined by L. W. Riddle.

Pleurotus tessulatus (Bull.) Fr.

Camp Monroe, Fourth lake, Herkimer co. August. F. S. Boughton.

Polyporus dryadeus (Pers.) Fr.

Base of oak trees. Near Kenwood, Albany co. August.

Puccinia urticae (Schum.) Lagerh.

On leaves of some species of Carex. West Albany. Formerly confused with Puccinia angustata Pk.

Riccardia sinuata (Dicks.) Limpr.

Damp decaying prostrate trunks of trees. Little Moose lake, Herkimer co. September. Miss C. C. Haynes.

Russula ballouii n. sp.

Plate IX, figures 1–4

Pileus thin, broadly convex, nearly plane or slightly depressed in the center, yellow when moist, grayish yellow when the moisture has escaped, the pale brick-red cuticle cracking into minute scales everywhere except in the center; lamellae thin, narrow, close, adnate or subdecurrent, pale yellow, becoming pruinose or dusted by the white spores; stem firm, equal or slightly tapering downward, the surface colored and adorned like the pileus; spores subglobose, 8–10 μ.

Pileus 2–3 cm broad; stem 2–3 cm long, 8–10 mm thick.

Woods, specially under poplar trees. Near Bullshead, Richmond co. October. W. H. Ballou.

Pileus tenuis, late convexus, subplanus vel in centro leviter depressus, humidus luteus, siccus griseo-luteus, ubique, disco excepto, squamis minutis lateritiis ornatus; lamellae tenues, angustae, confertae, adnatae vel subdecurrentes, pallidae vel pruinosae; stipes firmus, aequalis vel leviter sursum crassus, pileo similis ornatus et coloratus; sporae subglobosae, 8–10 μ.

Septoria margaritaceae n. sp.

Spots mostly large, .5–2 cm long, commonly one on a leaf, brown; perithecia epiphyllous, minute, about .25 mm wide, black; spores filiform, curved or flexuous, 40–80 x 1–2 μ, commonly attenuated toward the apex, oozing out and forming a whitish or yellowish white mass on the apex of the perithecium.

On languishing leaves of pearly everlasting, Anaphalis margaritacea (L.) B. & H. White Lake, Oneida co. August.

Usually there is a single large spot on a leaf but occasionally there are several smaller spots occupying the whole leaf.

Maculae vulgo magnae, .5–2 cm longae, vulgo solitariae, brunneae; perithecia epiphylla, minuta, circiter, .25 mm lata, atra; sporae filiformes, curvae vel flexuosae, 40–80 x 1–2 μ, vulgo ad apicem attenuatae, exudantes et globulum albidum formantes.

Silene dichotoma Ehrh.

Marietta, Onondaga co. S. N. Cowles. An introduced species.

Tricholoma latum Pk.

Plate IX, figures 5–8

Pileus fleshy, firm but flexible, broadly convex or nearly plane, moist, glabrous, white or whitish, flesh white, taste disagreeable;

lamellae plane or slightly arcuate in mass, narrow, close, rounded behind, adnexed, white or whitish, becoming dingy or tinged with reddish brown when old; stem short, nearly equal, solid or stuffed, slightly pruinose at the top, more or less white tomentose at the base, colored like the pileus; spores oblong or subfusiform, 10–12 x 3.5–4 μ.

Pileus 5–10 cm broad; stem 2.5–5 cm long, 1.5–2 cm thick. Gregarious. Woods, Vaughns. September. S. H. Burnham.

Pileus carneus, firmus, flexuosus, late convexus vel subplanus, humidus, glaber, albus albidusve, carne albus, sapor ungratus; lamellae planae vel leviter arcuatae; confertae, angustae, adnexae, albae albidaeve, in senectute sordidae; stipes brevis, subaequalis, solidus vel farctus, ad apicem subpruinosus, basi albotomentosus, pileo similis coloratus; sporae oblongae vel subfusiformes, 10–12 x 3.5–4 μ.

Tricholoma piperatum Pk.

Orient Point. November. R. Latham.

Tricholoma subpulverulentum (Pers.) Fr.

Near Rochester. October. W. E. Abbs. Only two specimens were received. The species has been regarded as edible, but it was not possible to obtain enough fairly to try its edible quality.

Urophlyctis major Schroet.

Living or languishing leaves of water plantain, Alisma plantago-aquatica L. Ithaca flats. July. B. B. Higgins. Communicated by G. F. Atkinson.

Vermicularia hysteriiformis n. sp.

Perithecia thin, oval or oblong, .4–.8 mm long, shining, black, covered by the epidermis and at length adorned with numerous subulate divergent black or brown setae; spores narrowly fusiform, acute at each end, slightly curved, hyaline, 20–30 x 3–4 μ.

Dead stems of blue cohosh, Caulophyllum thalictroides (L.) Mx. Troupsburg, Steuben co. May.

A species very distinct from all others by the shape of the perithecia which appear longer than broad through the epidermis, resembling in this respect some species of Hysterium.

Perithecia tenua, ovalia oblongave, .4–.8 mm longa, nitida, atra, primum epidermide tecta, demum setis numeris subulatis, divergen-

tibus atris vel fuscis ornata; sporae anguste fusiformes, utrinque acutae, leviter curvae, hyalinae, 20–30 x 3–4 μ.

Verrucaria muralis Ach.

Limestone rocks. Vaughns. April. S. H. Burnham.

Verrucaria papularis Fr.

Limestone rocks. Indian ladder, Helderberg mountains, Albany co. April. S. H. Burnham. Determined by G. K. Merrill.

Vicia hirsuta (L.) S. F. Gray

Richmond co. June. N. L. Britton. An introduced species.

Zygodesmus avellanus Sacc.

On wood of wild cherry. Lyndonville. April. C. E. Fairman.

REMARKS AND OBSERVATIONS

Aecidium hydnoideum B. & C.

This parasitic leaf fungus attacks living leaves of the leatherwood, Dirca palustris L. It usually forms a single large yellowish or reddish yellow spot on a leaf. A single cluster of cups commonly occupies each spot.

Agrostis borealis Hartm.

Along McIntyre brook, Adirondack mountains. July. This is an unusual form having the awn of the spikelet short and not exserted.

Boletus scaber Fr.

In this species the hymenium or mass of tubes is usually more or less depressed around the stem. In three specimens collected in Rosedale, Long Island, by F. H. Ames the tubes are adnate at first and then in drying separate from the stem carrying with them a thin layer of the external coating, thereby forming a cuplike depression about its insertion.

Boletus subaureus rubroscriptus n. var.

Pileus variously marked with red lines. Rochester. September. W. E. Abbs.

Pileus lineis rubris variis notatus.

Cladonia cristatella vestita Tuck.

Sandy soil. Orient Point. November. R. Latham.

Clavaria obtusissima minor n. var.

Plant smaller than the type, with more numerous and more slender branches and branchlets, the ultimate ones not so distinctly consolidated nor umbilicate, but obtuse or obtusely dentate.

Bolton, Warren co. September. For the description of the species see chapter on "New species of extralimital fungi."

Minor, rami ramulique numerosiores et graciliores, ultimati non distincte consolidati ne umbilicati, sed obtusi vel obtuse dentati.

Cynanchum nigrum (L.) Pers.

The black swallowwort is abundant near Rochester not far from Cobbs Hill reservoir. It usually grows in small patches of six to ten feet in diameter. The pods often divaricate in such a way as to give a somewhat stellate appearance to their arrangement.

Cytospora chrysosperma (Pers.) Fr.

Bark of glaucous willow, Salix discolor Muhl. Alder creek, Oneida co. In this form the spore tendrils assume an orange color instead of golden yellow as in the type.

Flammula spumosa unicolor n. var.

Pileus uniformly yellow; otherwise as in the type. In marshy woods. Karner, Albany co. July.

Fomitiporia prunicola Murr.

A form of this species which usually grows on trunks of wild bird cherry or pin cherry, Prunus pennsylvanica L., was found growing on a trunk of the canoe birch, Betula alba papyrifera (Marsh.) Spach, in the Adirondack mountains. The form growing on canoe birch was not distinguishable in any way from that on cherry. It might be called Fomitiporia prunicola f. betuli cola.

Habenaria fimbriata (Ait.) R. Br.

This large and fine purple-fringed orchis is remarkable for the durability of its flowers. A vase of the cut flowers has been known to remain perfectly fresh in appearance, at least ten days, with no other care than an occasional supply of fresh water. This is remarkable since its natural habitat is in wet marshy ground and often in the shade of trees. It is not rare in wooded marshes at North Elba. If a suitable habitat could be furnished it would make a fine addition to the ornamental plants of parks and gardens.

Ilex monticola Gray

Woodsworth lake, Fulton county. June. C. P. Alexander. This is an outlying station about seventy-five miles north and west of its nearest previously recorded localities, Taconic, Shawangunk and Catskill mountains, Gray's new Manual mentions Cattaraugus county also as a station for it, but this is apparently a far western outlying station.

Jeffersonia diphylla (L.) Pers.

Moist woods. Pittsford. Fine flowering specimens of this rare plant were collected April 15th and contributed by M. S. Baxter. He also contributed a fine fruiting specimen from High island, Potomac river, Maryland.

Lonicera hirsuta Eaton

This pretty, climbing shrub sometimes attains a comparatively large size. An example was observed in North Elba with the shrub approximately 2 cm in diameter and 3 or 4 m tall.

Pholiota cerasina Pk.

Specimens of this rare species were collected in Inlet, Hamilton co. and contributed by F. C. Stewart. It is peculiar in its cherry-like odor by which it is easily recognized.

Picea canadensis (Mill.) BSP.

Cambridge water works swamp, Washington co. July. F. Dobbin and S. H. Burnham. This swamp is a large one, covering an area of approximately one square mile and the stream flowing through it is fed by cold springs which probably aid in making it a suitable habitat for this northern cold-loving spruce. This is doubtless the southern limit for it in our State and an outlying station in which it has been able to maintain itself by reason of the cold character of the soil. Nevertheless the shortness of the leaves of these specimens indicate that its environment here is not favorable to its most vigorous development. Still it bears cones though not of large size.

Pleurotus ostreatus magnificus n. var.

Pileus very large, 12–30 cm broad, glabrous, often pitted toward the margin, pallid or subalutaceous; lamellae whitish, anastomosing at the base; stem 5 to 10 cm long, eccentric, strigose, variable, whitish; spores 10–14 x 4–5 μ.

On an old log near the ground. Shakers, Albany co. November. S. H. Burnham.

Pileus maximus, 12–30 cm latae, glaber, saepe margine lacunosus, pallidus subalutaceusve; stipes 5 to 10 cm longus, eccentricus, strigosus, variabilis, albidus; sporae 10–14 x 4–5 μ.

Polystichum braunii (Spenner) Fee

A new station for this rare fern has been discovered in our State by Edgar Tweedy, a lover of both plants and birds. It is in North Elba and is at present its most northern New York station known to me. It had previously been found in several places in the Catskill mountains, also near Summit, Schoharie co., and Hague,

Warren co. It is limited in quantity in the North Elba locality and it is hoped that any one finding it will be careful not to exhaust the locality.

Seligeria pusilla B. & S.

Limestone rocks. Chilson lake, Essex co. Mrs N. L. Britton. This is the second New York locality for this very rare little moss.

Senecio robbinsii Oakes

The Robbins' ragwort has become very abundant in some of the low wet meadows in North Elba and constitutes a large percentage of the hay cut from them. It is uniformly spread over the meadows and when in flower gives to them a more subdued yellow hue than the common buttercup gives to drier meadows earlier in the season.

Serapias helleborine L.

This rare and somewhat local plant occurs in many places in deep woods in Monroe county. The suggestion that it may have been introduced for medicinal purposes does not seem to be well sustained, since inquiry by a resident of the locality among some of the oldest inhabitants there failed to elicit any evidence to substantiate such a supposition. A fine, unusually heavy, fruited form of the species was found growing in dense woods along the banks of the Genesee river below Rochester by M. S. Baxter.

Trillium grandiflorum (Mx.) Salisb.

A " double flowered " form of this beautiful trillium has appeared several years near Howes Cave and is apparently permanently established. It has three whorls of petals beside the calyx lobes, but no stamens or pistils. It is needless to say that it bears no fruit, as all the essential organs of the flower are transformed into petals. It was discovered there in May by F. W. Kelley of Albany who has kindly contributed a specimen to the herbarium.

NEW SPECIES OF EXTRALIMITAL FUNGI

Asteromella asteris

Perithecia superficial, epiphyllous, densely cespitose, seated on an obscure thin brown crust, globose, about .25 mm broad, black, the tufts about 1 mm broad; spores minute, oblong or subcylindric, continuous, hyaline, 6–8 x 2–2.5 μ, sporophores minute or obsolete.

Upper surface of living or languishing leaves of the panicled aster, Aster paniculatus Lam. Louisville, Kan. October. E. Bartholomew.

Perithecia superficialia, epiphylla, dense aggregata, crusta tenue obscura brunnea insidentia, globosa, atra, caespites 1 mm lati; sporae minutae, oblongae vel subcylindraceae, continuae, hyalinae, 6–8 x 2–2.5 μ, sporophores minuti vel obsoleti.

Boletinus solidipes

Pileus fleshy, convex becoming broadly convex or nearly plane, squamose with radiately arranged closely appressed brown or purplish brown hairs, sometimes purplish brown or yellowish brown in the center, flesh whitish; tubes small, angular, radiately arranged, grayish becoming brown, adnate or decurrent; stem equal, solid, slightly annulate, yellowish below the annulus, grayish above, often stained with darker spots or marks, white or yellowish within, veil grayish, adhering partly to the margin of the pileus, partly to the stem; spore print ochraceous, spores 8–10 x 4–5 μ.

Pileus 5 to 10 cm broad; stem 5–8 cm long, 8–10 mm thick. Friendship, Me. August. G. E. Morris.

This species resembles in some respects Boletinus cavipes Opat. but it is somewhat darker in color and differs specially in its solid stem.

Pileus carnosus, convexus, demum late convexus vel subplanus, pilis purpureo-brunneus radiantibus appressis squamosus, interdum in centro lutescente brunneus, carne albido; tubuli parvi, angulares, radiantes, adnati vel decurrentes, grisei, deinde brunnei; stipes aequalis, solidus, leviter annulatus, infra annulum luteolus, supra annulum griseus, saepe maculis brunneis inquinatus, intra albidus, velo griseo, margini partim pilei et partim stipiti adherente; sporae subochraceae, oblongae, 8–10 x 4–5 μ.

Clavaria obtusissima

Much branching from a short thick whitish stem, the branches curving, dividing irregularly, enlarged above and divided into several blunt, wrinkled ends, longitudinally wrinkled, ochraceous, flesh white, taste mild; spores ochraceous in mass, oblong or subcylindric, 12–16 x 5–6 μ.

Plant 10–12 cm tall, 6–10 cm broad.

Woods of deciduous trees. West Roxbury, Mass. September. Miss Ann Hibbard.

Stipes crassus, brevis, ramosissimus, ramosi ramulosique curvati, supra sulcati et incrassata, ochracei, caro albus, sapor mitis; sporae ochroceae, oblongae vel subcylindraceae, 12–16 x 5–6 μ.

Clavaria subcaespitosa

Forming dense tufts 7.5–12.5 cm tall, fragile, white or whitish, the stems united at the base, three to five times dichotomously divided, the terminal branchlets obtuse or subacute, both stems and branches solid, soft, becoming thinner and flattened or angular in drying, flesh white, taste mild; spores broadly ellipsoid or subglobose, 4–5 x 3–4 μ.

Ground. Ellis, Mass. September. Mrs E. B. Blackford and G. E. Morris. Communicated by Miss Ann Hibbard.

This species may be separated from Clavaria densa Pk. by its greater fragility, whiter color, softer texture and smaller spores. In the dried specimens the stems and branches are much more slender and of a purer white color than in C. densa.

Stipes brevis, crassus, dichotome ramosissimus, caespites densus 7.5–12.5 cm longos fragiles formans; rami ramulique obtusi vel subacuti, solidi, molles, in siccitate tenuiores et deplanati vel angulares, carno albo, sapore mite; sporae late ellipsoideae vel subglobosae, 4–5 x 3–4 μ.

Clitopilus leptonia

Pileus thin, conic or convex, umbilicate, hygrophanous, squamulose in and near the broad umbilicus, chestnut color and striatulate on the margin when moist, black in the umbilicus; lamellae broad, broadly simuate adnate or decurrent, distant, white becoming pink, sometimes transversely venose; stem slender, equal or slightly narrowed upward, fibrillose, straight, stuffed or hollow, brown becoming darker with age, with a copious white myceliod tomentum at the base; spores subglobose, angular, uninucleate, 10–12 x 8–10 μ.

Pileus 2.5–3.5 cm broad; stem 5–8 cm long, 1–3 mm thick.

Gregarious. Low ground under trees. Stow, Mass. September. S. Davis.

This slender species closely approaches some species of Leptonia in general appearance. This character has suggested the specific name. The more or less decurrent lamellae throw the species into the genus Clitopilus. It differs from Clitopilus vilis Fr. by the color of the pileus and by its larger spores, and from C. subvilis Pk. by the color of the pileus and its squamulose center. In the dried state the pileus and stem are black and the margin of the pileus is sulcate striate.

Pileus tenuis, conicus vel convexus, umbilicatus hygrophanus, centro umbilicoque squamulosus alibi glaber, udus, castaneus, margine striatulatus, in umbilico ater; lamellae latae, late adnatae vel decurrentes, distantes, albae, demum incarnatae, interdum transverse venosae; stipes gracilis, aequalis, vel leviter seorsum attenuatus, fibrillosus, rectus farctus cavusve, brunneus, basi abundante albo tomentoso; sporae subglobosae, angulares, uninucleatae, 10–12 x 8–10 μ.

Pileus 2.5–3.5 cm latus; stipes 5–8 cm longus; 1–3 mm crassus.

Coryneum effusum

Forming thinly effused indefinite black patches on wood, mycelium subhyaline, sporophores slender, often flexuous and tapering downward, subhyaline, 12–30 μ long; spores oblong or subfusiform, straight or slightly curved 2-septate when mature, the central cell black, the terminal cells subhyaline, one or both finally subtruncate, 20–28 x 10–12 μ, the central cell 10–12 μ long.

Wood of western cottonwood, Populus occidentalis Rydb. Stockton, Kan. March. E. Bartholomew.

Differs from typical species of Coryneum in forming no definite acervuli or subcutaneous erumpent heaps but in developing in effused patches on decorticated wood.

Coryneum tenuiter effusum, in ligni superficiei areas atras indefinitas formans; sporae oblongae vel subfusiformae, rectae vel leviter curvae, in maturitate biseptatae, loculo centrale atro, terminalibus subhyalinis, saepe truncates, 20–28 x 10–12 μ, loculus centralis 10–12 μ longus.

Diatrype tumidella

Stroma orbicular, plane or convex, 1–2 mm broad, surrounded by a black line which penetrates to the wood, erumpent and

surrounded by the ruptured fragments of the epidermis, the surface at first pallid or brownish and dotted by the black sulcate ostiola, becoming blackish with age, whitish within; perithecia monostichous, black within, 4–12 in a stroma; asci subclavate or cylindric, the sporiferous part 35–50 x 8–10 μ; spores crowded or subbiseriate, straight or slightly curved, obtuse at each end, fuscous, 10–20 x 4–5 μ.

Dead branches of pin cherry, Prunus pennsylvanica L. Ste. Anne de Bellevue. Quebec, Canada. W. P. Fraser.

Closely related to Diatrype tumida E. & E., from which it differs in its smaller stroma, its broader asci and specially in its broader and darker spores.

Stroma orbiculare, disciforme vel convexum, 1–2 mm latum linea atra ad lignum penetrante cinctum, epidermidis ruptae fragmentis cinctum primum pallide brunneum, demum nigrum, ostiolis sulcatis punctatum intra albidum; perithecia monosticha, intra atra, in stromate 4–12; asci subclavati vel cylindracei, 35–50 x 8–10 μ; sporae confertae vel subbiseriatae, rectae vel leviter curvae, putrinque obtusae, fuscae, 10–20 x 4–5 μ.

Eccilia regularis

Pileus thin, submembranaceous, convex, finely striate to the center, distinctly umbilicate, bright buff or pinkish buff, sometimes with an orange spot in the center when moist, becoming silky in drying; lamellae close, arcuate, decurrent, soon pink; stem colored like or a little paler than the pileus; spores angular, uninucleate, 8–10 x 7–8 μ.

Pileus 2–3 cm broad; stem 4–6 cm long, 2–3 mm thick.

Ground in woods. Friendship, Me. August. G. E. Morris.

This is a small but beautiful and very regular or symmetrical species. It is nearly uniformly colored throughout, being a yellowish or pinkish buff. The dried specimens are tawny ochraceous. Under a lens they appear to have the pileus minutely striate.

Pileus tenuis, submembranaceous, convexus, minute striatus, umbilicatus, late luteolus vel incarnate luteolus, interdum udus in centro aurantiacus, siccus sericeus; lamellae confertae, arcuatae, decurrentes, mox incarnatae; stipes gracilis, aequalis, farctus, rectus, glaber, pileo in colore similis vel pallidior; sporae angulares, uninucleatae, 8–10 x 7–8 μ.

Pileus 2–3 cm latus; stipes 4–6 cm longus, 2–3 mm crassus.

Entoloma fumosonigrum

Pileus fleshy, thin, convex or nearly plane, involute on the margin, dry, subglabrous, smoky black, flesh white, taste disagreeable; lamellae moderately close, sinuate adnate, eroded on the edge, at first white, then pale pink; stem slender, equal or slightly tapering upward, stuffed, glabrous or fibrillose, pruinose at the top, colored like or a little paler than the pileus, with a white mycelioid tomentum at the base, sometimes wholly white; spores subglobose, slightly angular, uninucleate, often with an oblique apiculus at one end, 8–10 μ long.

Pileus 2–5 cm broad; stem 4–5 cm long, 2–4 mm thick.

Under trees in swamps. Stow, Mass. September. S. Davis.

Apparently related to Entoloma melaniceps C. & M. from which it is separated by its stuffed stem and smaller spores. From E. fuliginarium Karst. by the even margin of the pileus and the paler color of the lamellae.

Pileus carnosus, tenuis, convexus vel subplanus, margine involutus, siccus, subglaber, fumoso niger, carne alba, sapore ingrato; lamellae subconfertae, sinuatae, adnatae, acie erosae, primum albae, demum pallide incarnatae; stipes gracilis, aequalis vel leviter sursum attenuatus farctus, glaber vel leviter fibrillosus, ad apicem pruinosus, pileo in colore similis vel pallidior basi tomento albo ornatus, interdum omnino albidus; sporae subglobosae, leviter angulares uninucleatae, saepe oblique apiculatae, 8–10 μ longae.

Pileus 2–5 cm latus; stipes 4–5 cm longus, 2–4 mm crassus.

Flammula brunneodisca

Pileus fleshy, thin, broadly convex or nearly plane, umbonate, slightly viscid with a separable pellicle, slightly innately fibrillose, ochraceous yellow with a brown center, flesh white; lamellae thin, close, adnate with a decurrent tooth, pale yellow becoming rusty brown; stem slender, equal, solid, glabrous, pale yellow without and within, paler at the top; spores ellipsoid, 6–8 x 4–5 μ.

Pileus 2.5–6 cm broad; stem 2–3 cm long, 4–6 mm thick.

Cespitose. "On ground at the edge of a stone but probably growing from a buried root." Waltham, Mass. October. G. E. Morris.

Pileus carnosus, tenuis, late convexus vel subplanus, umbonatus, leviter viscidus, obscure et innate fibrillosus, pallide ochrace-

o-luteus, in centro brunneus, carne alba; lamellae tenues, confertae, adnatae, dente decurrentes, pallide luteae ferrugineo-brunnescentes; stipes aequalis, gracilis, solidus, glaber, pallide luteus, ad apicem pallidior; sporae ellipsoideae, 6–8 x 4–5 μ.

Pileus 2.5–6 cm latus; stipes 2–3 cm longus, 4–6 mm crassus.

Flammula sphagnicola

Pileus fleshy, thin, convex or nearly plane, obtuse or umbonate, viscid, glabrous, yellowish with reddish or reddish brown often spotted center, flesh white; lamellae thin, narrow, close, adnate or with a decurrent tooth, whitish becoming cinnamon color; stem slender, equal or slightly enlarged at the base, hollow, whitish, slightly white fibrillose at the top, with a white tomentum at the base; spores ellipsoid, uninucleate, 8–10 x 4–6 μ.

Pileus 1–2.5 cm broad; stem 2.5–3.5 cm long, 1–3 mm thick.

Among sphagnum in swamps. Amesbury, Mass. September. G. E. Morris.

Pileus carneus, tenuis vel subplanus, obtusus vel umbonatus, viscidus, glaber, lutescens rufescens vel rufo-brunneus, in centro saepe maculatus, carno albo; lamellae tenues, angustae, confertae, adnatae, interdum dente decurrentes, albidae demum cinnamomeae; stipes gracilis aequalis vel basi crassus, cavus, albidus, ad apicem leviter fibrillosus, basi tomento albo; sporae ellipsoideae, uninucleatae, 8–10 x 4–6 μ.

Pileus 1–2.5 cm latus; stipes 2.5–3.5 cm longus, 1–3 mm crassus.

Hysteriographium acerinum

Perithecia subsuperficial, subseriate broadly elliptic or oblong, even, black, 1–3 mm long, .5–1 mm broad; asci subcylindric, 120–170 μ long; spores crowded, oblong or subfusiform, 7–10-septate, muriform, 35–50 x 12–16 μ.

Decorticated wood of Rocky mountain maple, Acer glabrum Torr. Boulder, Col. August. E. Bartholomew.

Perithecia superficialia, subseriatim disposita, late ellipsoidea vel oblonga, levia, atra, 1–3 mm longa, .5–1 mm lata; asci subcylindracei, 120–170 μ longi; sporae confertae, oblongae vel subfusiformes, 7–10-septatae, muriformes, 35–50 x 12–16 μ.

Inocybe castaneoides

Pileus thin, conic or convex becoming nearly plane, broadly umbonate, fibrillose, squamulose on the umbo, striatulate on the

margin, rimulose, chestnut color when young, becoming reddish brown; lamellae thin, close, sinuate, adnexed, whitish becoming ferruginous, whitish on the edge; stem brittle, flexuous, fibrillose, solid or stuffed, white becoming reddish brown, a slight white veil is sometimes seen in the very young plant; spores 8–10 x 6–8 μ, cystidia rare, 40–50 x 15–20 μ.

Pileus 1.5–2.5 cm broad; stem 2–4 cm long, 1–2 mm thick.

Gregarious. Roadsides under grass and ferns. Stow, Mass. September. S. Davis.

This species belongs to the section Rimosi. It is allied to Inocybe castanea Pk. from which it differs in its squamulose umbo, sinuately adnexed lamellae, its stem white when young, the presence of an evanescent veil, its more distinctly nodulose spores and its broader, shorter cystidia.

Pileus tenuis, conicus vel convexus, deinde subplanus late umbonatus, fibrillosus, in umbone squamulosus, in margine striatulatus, in juventate castaneus, demum fuscus; lamellae tenues, confertae, sinuatae, adnexae, albidae, deinde ferrugineae, acie albidae; stipes fragilis, flexuosus, fibrillosus, farctus vel solidus, albus demum fuscus, velo albo evenescente; sporae subglobosae, irregulare nodolosae, uninucleatae, 8–10 x 6–8 μ, cystidia sparsa, 40–50 x 15–20 μ.

Lophiostoma sieversiae

Perithecia minute, about .25 mm broad, erumpent, black; asci oblong, 150–280 x 50–70 μ, usually 8-spored; spores oblong or subfusiform, 3-septate, at first involved in mucus, 50–75 x 20–25 μ.

Dead stems of Sieversia turbinata (Rydb.) Greene. Big Cottonwood canyon, Utah. July. A. O. Garrett.

Perithecia minuta, .25 mm lata, erumpentia, atra; asci oblongi, 150–280 x 50–70 μ, vulgo 8-sporis; sporae oblongae vel subfusiformes, 3-septatae, primum in muco involutae, 50–75 x 20–25 μ.

Marasmius trullisatipes

Pileus thin, campanulate or convex, acutely umbonate, glabrous, isabelline or subrufescent; lamellae thin, subclose, broad anteriorly, adnate, whitish tinged with pink; stem tough, solid, white within, pruinose above, tomentose below, externally cartilaginous; spores 6 x 4 μ.

Pileus 1.2–2 cm broad; stem 3–5 cm long, 2–3 mm thick.

Ground. Near Minneapolis, Minn. May. Mrs M. S. Whetstone. Also Cedar Point, Ohio. July. C. K. Brain.

The umbo in the dried specimens sometimes appears blackish. The tomentum of the lower part of the stem binds together particles of earth and causes the stem to appear thickened at the base or deeply rooted in the ground.

Pileus tenuis, campanulatus vel convexus, acute umbonatus, glaber, isabellinus vel subrufescens; lamellae tenues, subconfertae, anteriore latae, adnatae, incarnato-albidae; stipes tenax, solidus, intus albus, ad apicem pruinosus, basi tomentosus, extus cartilaginous; sporae 6 x 4 μ.

Pileus 1.2–3 cm latus; stipes 3–5 cm longus, 2–3 mm crassus.

Monilia sidalceae

Widely effused on the lower surface of the leaf, tufts at first white, then brownish; hyphae very short; spores oblong elliptic or globose, hyaline, 16–20 x 12–14 μ or 12–14 μ broad.

Living leaves of Sidalcea nervata A. Nels. Red Butte canyon, Utah. July. A. O. Garrett.

Caespites late effusi, hypophylli, albi, brunnescentes; hyphae brevissimae; sporae oblongae ellipsoideae vel globosae, hyalinae, 16–20 x 12–14 μ vel 12–14 μ latae.

Nolanea multiformis

Pileus fleshy, thin, convex nearly plane or centrally depressed, fragile, glabrous or slightly fibrillose, brown or blackish brown, striatulate on the margin which becomes wavy split or irregular when old; lamellae thin, subdistant, broad, adnate, white becoming pink; stem equal, fragile, flexuous, glabrous or fibrillose, solid or hollow, white or brown; spores subglobose, angular, uninucleate, 10–12 x 8–10 μ.

Pileus 1–3 cm broad; stem 1–2 cm long, 1–2 mm thick.

Gregarious. Grassy ground. Brookline, Mass. September. S. Davis.

This species is apparently allied to Nolanea aethiops Fr. from which it may be separated by the striatulate margin of the pileus, the absence of black dots or points from the top of the stem and by its more globose spores. In the dried specimens the pileus is often plicate. When fresh the stem is sometimes white both at the top and bottom but brown in the middle.

Pileus carnosus, tenuis, convexus subplanus vel in centro depressus, fragilis, glaber vel leviter fibrillosus, brunneus vel nigresco-brunneus, in margine striatulatus, demum undatus rimosus vel irregularis; lamellae tenues, subdistantes, latae, adnatae, albae incarnatescentes; stipes aequalis, fragilis, flexuosus, glaber vel fibrillosus, solidus vel cavus, albus brunneusve; sporae subglobosae, angulares, uninucleatae, 10–12 x 8–10 μ.

Pileus 1–3 cm latus; stipes 1–2 cm longus, 1–2 mm crassus.

Polycephalum subaurantiacum

Stem slender, 1–3 mm long, slightly attenuated upward, thickened or bulbous at the base, clothed with ascending mostly whitish hairs, simple or slightly branched above, composed of united hyphae, orange colored below, white above, the fertile ones bearing 1–4 globose or subglobose minute whitish heads of spores; spores ellipsoid or subglobose, hyaline, 4–6 x 3–4 μ.

Gregarious on branchlets of avocado or alligator pear, Persea gratissima Gaertn. f. Cuba. September. Communicated by M. T. Cook.

Sometimes two or three stems start from the same hairy bulb. The species is apparently closely related to Polycephalum aurantiacum K. & C. and may be a variety of it but from which it may be separated because of its slender generally tapering or subulate stem which is white above and because of its larger spores. The hairs of the bulb are usually concolorous with it, those of the stem are white or whitish. They are apparently the diverging tips of some of the component hyphae of the stem.

Stipes gracilis, 1–3 mm longus, sursum leviter attenuatus, basi crassus vel bulbosus, vulgo pilis ascendentibus albidis hirtus, simplex vel leviter supra ramosus, hyphis coalitis compositus, infra aurantiacus, supra albus, fertilibus sporarum capita 1–4 minuta globosa vel subglobosa albida producentibus; sporae ellipsoideae vel subglobosae, 4–6 x 3–4 μ.

Psilocybe cystidiosa

Pileus thin, convex or subconic, glabrous, hygrophanous, pale brown when moist, yellowish drab with a brownish center and sometimes obscurely striate on the margin when dry, sometimes becoming lacerated when expanded, flesh white, taste nutty; lamellae thin, close, adnate, whitish becoming purplish brown,

stem equal or slightly tapering upward, hollow, pruinose at the top, white, often with a subglobose mass of earth adhering to the base; spores purplish brown, ellipsoid, 8–10 x 5–6 μ, cystidia 60–80 x 12–20 μ.

Pileus 2–4 cm broad; stem 4–5 cm long, 2–4 mm thick.

Solitary or clustered. Minneapolis, Minn. August. Mrs M. S. Whetstone.

Pileus tenuis, convexus vel subconicus, glaber, hygrophanous, pallide brunneus humidus, luteolus siccus, mox in centro brunneus et obscure in margine striatus, mox expansus laceratescens, carne alba, sapore nucino; lamellae tenues, confertae, adnatae, albidae, purpureo-brunnescentes; stipes aequalis vel leviter deorsum attenuatus cavus, ad apicem pruinosus, albus, basi congiobatus; sporae purpuroe-brunneae, ellipsoidae, 8–10 x 5–6 μ, cystidia 60–80 x 12–20 μ.

Pileus 2–4 cm latus; stipes 4–5 cm longus, 2–4 mm crassus.

Psilocybe graveolens

Cespitose, strongly odorous; pileus hemispheric or convex, glabrous, varying in color from creamy white to subalutaceous, flesh pallid; lamellae close, subventricose, rounded behind, adnexed, brown when mature; stem equal, silky fibrillose, stuffed or hollow, white; spores subelliptic, 8–10 x 5–6 μ.

Hackensack marshes, New Jersey. November. W. H. Ballou.

This species is remarkable for its strong, persistent odor.

Plantae caespitosae, graveolentes; pileus hemisphaericus vel conconvexus, glaber, cremeo subalutaceus, carne pallido; lamellae confertae, subventricosae, adnexae, in maturitate brunneae; stipes aequalis, sericeo-fibrillosus, confertus vel cavus, albus; sporae subellipticae, 8–10 x 5–6 μ.

Ramularia anomala

Tufts forming indefinite whitish patches on the lower surface of the leaves with no discolored spot and scarcely visible to the naked eye; hyphae very minute, densely crowded about 20 μ long; spores oblong or cylindric, continuous, hyaline, subacute, 12–20 x 3–4 μ.

Living leaves of climbing false buckwheat, Polygonum scandens L. Red Cloud, Neb. J. M. Bates. Communicated by E. Bartholomew.

Unlike most species of Ramularia, this has no discolored spots on the leaves of the host plant.

Caespites areas indefinitas albidas obscuras in superficiei foliorum inferiore formantes, macula nulla discolorata, fungoque oculo inermi vix visible; hyphae minutissimae dense confertae circiter 20 μ longae; sporae oblongae vel cylindraceae, continueae, hyalinae utrinque, subacutae, 12–20 x 3–4 μ.

Septoria polemonioides

Spots suborbicular, brown or brown with a whitish center, perithecia epiphyllous, black; spores slender, straight or curved, pointed at each end, continuous, hyaline, 30–60 x 1–1.5 μ.

Living or languishing leaves of some species of Polemonum. Utah. A. O. Garrett.

This species differs from Septoria polemonii Thuem, in its longer continuous and sharp pointed spores and in the color of the spots.

Maculae suborbiculares, brunneae, interdum centro albidae; perithecia epiphylla, atra; sporae graciles, rectae vel curvae, utrinque acutae, continuae, hyalinae, 30–60 x 11.5 μ.

Sphaerella saccharoides

Spots definite, oblong, .5–1 cm long, brownish on the margin; perithecia epiphyllous, minute, black; asci subcylindric, 70–80 x 12–14 μ; spores biseriate, oblong or subfusiform, constricted at the septum, each cell binucleate, hyaline, 25–30 x 5–6 μ.

Leaves of sugar cane, Saccharum officinarum L. Cuba. T. E. Thurston. Communicated by L. R. Hesler.

This species appears to be closely related to Sphaerella sacchari Speg. from which according to the description it differs in its definite whitish spots, in the longer asci and spores and in the latter being quadri-nucleate.

Maculae definitae, oblongae, .5–1 cm longae, margine brunescetes; perithecia epiphyllae, minutae, nigrae; asci subcylindracei, 70–80 x 12–14 μ; sporae in asco biseriatae, oblongae vel subfusiformes, ad septum constrictae, quadri-nucleatae, hyalinae, 25–30 x 5–6 μ.

Sporotrichum atropurpureum

Hyphae widely effused, forming a soft tomentose covering on the matrix, at first white, gradually becoming red, dark purple or violaceous, sparsely and irregularly branched, septate, often

granular within, 2–5 μ broad, sterile branches or mycelium gradually or sometimes abruptly tapering to a long slender point, the fertile often fasciculately combined; spores oblong or subcylindric, frequently narrowed toward one end, very variable, 6–16 x 2–4 μ.

On kernels of Indian corn, Zea mays L. Lexington, Ky. H. Garman.

This is a remarkable species by reason of the peculiar color of the mature fungus.

Mycelium late effusum; hyphae in matrice stratum molle tomentosum formantes, primum album, deinde rubrum vel atropurpureum, ramulis paucis irregularibusque, 2–5 μ latis, saepe intra granularibus, septatis, sterilibus praelonge attenuatis, fertilibus in maturitate frequenter et fasciatim combinatis; sporae oblongae vel subcylindaceae, saepe infra attenuatae, variabiles, 6–16 x 2–4 μ.

Stropharia umbilicata

Pileus fleshy, convex, deeply umbilicate, shining, squamose with scattered appressed brownish scales, umber brown, tinged with olive green when dry, the margin sometimes adorned with fragments of the veil, flesh yellowish; lamellae close, adnexed or almost free, sinuate, 2–3 mm broad, becoming sooty brown with a white edge; stem subequal, slightly broader at the top, stuffed or hollow, fibrillosely scaly, whitish above, rusty brown below, annulus superior, membranaceous; spores ellipsoid, 7–8 x 4–5 μ.

Pileus 4–5 cm broad; stem 2.5–4 cm long, 4–6 mm thick.

Cespitose. Chips and sawdust. Minnesota. September. Doctor Munger. Communicated by Mrs M. S. Whetstone.

Pileus carnosus, convexus, profunde umbilicatus, nitidus, squamulis sparsis appressis, brunneis ornatus, umbrinus, demum olivaceo-viride tinctus, interdum margine fragmentis veli triangularibus ornatus, carne lutescente; lamellae confertae, adnexae vel subliberae, sinuatae, 2–4 mm latae, demum fuliginosae, acie albidae; stipes subaequalis, farctus vel cavus, fibrilloso-squamulosus, supra albidus, infra ferrugineo-brunneus, annulo superiore, membranaceo; sporae ellipsoideae, 7–8 x 4–5 μ.

Pileus 4–5 cm latus; stem 2.5–4 cm longus, 4–6 mm crassus.

Volvaria perplexa

Pileus thin, convex or nearly plane, umbonate, slightly depressed around the umbo, dry, adorned with minute erect hairy

squamules, fimbriate on the even margin, white; lamellae close, free, about 2 mm broad in the widest part, pale pink; stem long, slender, glabrous, shining, solid or stuffed, slightly pruinose at the top, thickened at the base, white, brownish where bruised, volva closely sheathing, elongated; spores ellipsoid, 6–8 x 4–5 μ.

Pileus 12–20 mm broad; stem 5–7 cm long, 2–3 mm thick.

Solitary. Among fallen leaves in woods. Minnesota. November. Mrs M. S. Whetstone.

This species seems to be closely allied to Volvaria parvula Weinm. from which it is separated by its squamulose pileus with fimbriate margin, its much longer stuffed or solid stem and longer sheathing volva, its larger spores and by the absence of cystidia.

Pileus tenuis, convexus vel subplanus, umbonatus, circa umbonem leviter depressus, siccus, squamulis erectis hirtis minutis ornatus, margine leve fimbriatus, albus; lamellae confertae, liberae, circiter 2 mm latae, pallide incarnatae; stipes longus, gracilis, nitidus, glaber, solidus vel farctus, ad apicem leviter pruinosus, basi crassus, albus, ubi contusus brunnescens, volva elongata vaginata; sporae ellipsoideae 6–8 x 4–5 μ.

Pileus 12–20 mm latus; stem 5–7 cm longus, 2–3 mm crassus.

EDIBLE FUNGI

Amanita ovoidea Bull.

OVOID AMANITA

Plate 131

Pileus fleshy, hemispheric or expanded, glabrous, inflexed on the margin, pure white, flesh white, taste insipid; lamellae rather broad, subclose, ventricose, free or nearly so, white; stem equal or tapering upward, squamulose farinaceous, solid, firm, white without and within, bulbous at the base, annulate above; spores globose or subglobose, 10–12 x 9–11 μ or about 10 μ broad.

The ovoid amanita is a large, attractive and noble looking species. It is pure white throughout with the exception of the volva that envelops the bulbous base of the stem. This is slightly tinged with pink. The cap may range from 4 to 8 inches broad, the stem from 4 to 6 inches long and 6 to 12 lines thick. The cap is very smooth, almost glossy, and white as snow. The flesh also is white but its taste is insipid, and in cooking it is necessary to season it well with butter and salt to make it satisfactorily palatable. The stem is firm, solid, more or less mealy externally and pure white. The species is very rare having not before been found in our State so far as I know. In Sylloge, volume V, page 9, Professor Saccardo remarks that he has never seen its spores nor has anyone else so far as he knows. This remark no longer holds good. The New York specimens yielded spores. Since the species is cogeneric with some of our most poisonous species of mushrooms, we advise no one to try its edibility unless perfectly sure of its identity.

Tricholoma chrysenteroides Pk.

GOLDEN-FLESH TRICHOLOMA

Plate 132

Pileus fleshy, convex or nearly plane, glabrous, or slightly silky, firm, pale yellow or at length rufescent, the margin sometimes reflexed, flesh pale yellow, taste and odor farinaceous; lamellae close, adnexed, often with venose interspaces, yellowish, sometimes becoming dingy with age; stem equal, firm, glabrous, solid or stuffed, rarely hollow, yellowish without and within; spores ellipsoid, 8–10 x 5–6 μ.

The golden-flesh tricholoma is easily known by its pale yellow color and its farinaceous odor and taste. It is similar in color to Tricholoma sulphureum Bull. Its cap is one to two or sometimes two and a half inches broad, convex or nearly flat above or occasionally with the margin curved upward. It is smooth or slightly silky and its flesh is colored like the cap. Indeed the plant is nearly uniform in color throughout, except in old specimens in which the upper surface of the cap becomes reddish. The lamellae are rather close, adnexed, usually veiny in the interspaces and are apt to become dingy with age. The stem is equal in diameter throughout, firm, smooth or somewhat silky fibrillose, solid or rarely stuffed or slightly hollow when large or old and colored like the pileus. It was found growing under poplar trees among fallen leaves at Vaughns in September. When cooked it has an agreeable flavor but old specimens are liable to be somewhat tough, though still very palatable.

POISONOUS FUNGI

Mycena splendidipes Pk.

POISON MYCENA

Plate X

Pileus at first ellipsoid, even, the upper half brown, the lower half yellow, at length hemispheric or convex, submembranous, widely striate on the margin, glabrous, greenish gray; lamellae ascending, subdistant, white; stem slender, hollow, glabrous, bright shining lemon yellow; spores broadly ellipsoid or subglobose, 6–8 x 4–6 μ.

Pileus 6–10 lines broad; stem 2–6 inches long, .5–1 line thick.

Woods. Among fallen pine leaves. Richmond co. November. W. H. Ballou.

This is a beautiful little Mycena, very attractive in appearance by reason of its bright shining yellow stems and very interesting on account of the great change in appearance caused by its transformation from the young to the mature state. This is best expressed by the figures given in the plate. It is a veritable little siren. Its discoverer, venturing to eat a single sample of it was made sick by the experiment, and has furnished a warning to all future generations against its dangerous qualities.

CRATAEGUS IN NEW YORK

So much has been learned of the characters and distribution of the different species of Crataegus in New York during the last three or four years through the collections and observations of a number of students of these plants that it now seems desirable to join in a brief summary this information with that contained in the various publications on the subject which have appeared in the last ten years.

In western New York Crataegus has been more systematically and carefully collected and studied than in any other part of North America, but there is still much field work to be done before the species of the eastern, southern and central parts of the State are equally well known, and it is hoped that the publication of this synopsis of the work already accomplished may lead to further investigations and collections.

C. S. SARGENT

Arnold Arboretum
Jamaica Plain, Mass.
December 1912

KEY TO THE SPECIES

Synopsis of the groups

A Nutlets without ventral cavities..... (Groups Crus-galli-Anomalae)

B Nutlets with longitudinal cavities on their ventral faces..... (Group Tomentosae)

Crus-galli

Leaves subcoriaceous to coriaceous, obovate to oblong-obovate, usually rounded, or acute or acuminate at the apex, mostly serrate only above the middle, without lobes except on vigorous shoots, their veins thin and sometimes within the parenchyma, petioles short, usually eglandular; flowers in many-flowered corymbs; fruit subglobose to short-oblong, flesh thin, usually green.

* Veins of the leaves within the parenchyma; stamens 10
Anthers rose color .....C. crus-galli
Anthers white .....C. arduennae

** Veins of the leaves prominent

†Glabrous with the exception of occasional hairs on the young leaves; anthers pale pink

Stamens 9–10.....C. geneseensis
Stamens 10–20
Flowers at least 1.8 cm in diameter, in broad many-flowered corymbs; leaves broadly ovate; fruit crimson, spines stout .....C. robusta
Flowers not more than 1.2 cm in diameter, in few-flowered corymbs; leaves narrowly obovate; fruit bright cherry red; spines slender..C. cerasina
†† Corymbs more or less villose
Mature leaves glabrate; corymbs slightly villose; stamens 10–20, anthers dark rose color; fruit short-oblong to subglobose.....C. persimilis
Mature leaves pubescent below; corymbs densely villose; stamens 10–14, anthers white sometimes faintly tinged with pink; fruit short-oblong to obovoid.....
C. helderbergensis

Punctatae

Leaves thin, mostly acute or acuminate, usually more or less lobed above the middle, their veins prominent, petioles short; flowers in many-flowered corymbs; anthers rose color or pink (pale yellow in one variety of no. 1); fruit subglobose to ellipsoidal or obovoid, usually more or less flattened at the ends, punctate, flesh dry and mealy, nutlets 2–5, prominently ridged on the back.

* Stamens 20
Leaves more or less villose at maturity; anthers rose color, or yellow (in var. aurea); leaves obovate, often acutely lobed above the middle on vigorous shoots; fruit flattened at the ends, marked by large dots, dull red, or yellow (in var. aurea).....C. punctata
Leaves glabrous at maturity
† Anthers dark rose color
Pedicels stout, villose; calyx thickly coated with white hairs; fruit subglobose, crimson, lustrous
C. celsa
Pedicels slender, glabrous; calyx glabrous; fruit short-oblong to slightly obovoid
Flowers not more than 1.2 cm in diameter; fruit orange-red, lustrous; leaves cuneate at the base
C. notabilis

Flowers at least 2.5 cm in diameter; fruit dark crimson, pruinose; leaves cuneate or broad and rounded at the base.....C. eastmaniana

†† Anthers pink; corymbs glabrous

Flowers 1.8–2 cm in diameter; leaves ovate, oval or orbicular; fruit short-oblong, crimson, pruinose.... C. dewingii

Flowers not more than 1.5 cm in diameter; fruit not pruinose

Leaves ovate or obovate; fruit short-oblong to depressed-globose, bright cherry-red..... C. eatoniana

Leaves oblong-obovate; fruit oblong-obovoid, scarlet.....C. barbara

** Stamens 15–20, anthers rose color; leaves oblong-obovate to oval, rounded or acute at the apex; corymbs slightly villose; fruit short-oblong to slightly obovoid, dull brick-red .....C. pausiaca

*** Stamens 10; anthers rose color or pink corymbs slightly villose

Leaves rhombic or obovate, acuminate and long-pointed, glabrous; fruit short-oblong..... C. desueta

Leaves obovate to ovate, acute, villose while young; anthers pink; fruit subglobose to slightly obovoid.. C. brownietta

Pruinosae

Leaves thick, usually broad at the base, smooth or scabrate above; petioles long and slender; flowers in glabrous or hairy corymbs; stamens usually 10 or 20, anthers rose color, pink or white; fruit subglobose, often broader than high, short-oblong or obovoid, sometimes angled, green or red, generally pruinose, ripening late, flesh dry and hard, the mature calyx prominent, raised on a tube; nutlets 3–5.

*Stamens 20

† Mature leaves smooth and glabrous on the upper surface

‡ Fruit on slender drooping pedicels

Anthers rose color, red or maroon

Tube of the calyx of the fruit elongated; anthers dark rose color; leaves blue-green; fruit pruinose

Leaves elliptical; fruit subglobose, becoming dark red and very lustrous when fully ripe..... C. pruinosa

Leaves oblong-ovate; fruit obovoid, crimson.... C. oblita

Tube of the calyx of the fruit short

Upper surface of the young leaves glabrous

Fruit obovoid, slightly pruinose

Fruit conspicuously mammillate below the middle; leaves ovate to rhombic; anthers rose color.....C. arcana

Fruit not mammillate; leaves rhombic; anthers maroon.....C. obstipa

Fruit short-oblong to slightly obovoid, densely pruinose; leaves oblong-ovate; anthers maroon .....C. beata

Upper surface of the young leaves covered with soft hairs

Leaves broadly ovate; anthers red; flowers 2.5 cm in diameter in 10–15-flowered corymbs; fruit short-oblong; cavity of the calyx pointed in the bottom.....C. pallescens

Leaves ovate; anthers rose color; flowers not more than 2 cm in diameter, in 5- or 6-flowered corymbs; fruit subglobose to obovoid; cavity of the calyx wide in the bottom..... C. pelacris

Anthers pink

Tube of the calyx of the fruit elongated; fruit pruinose

Leaves ovate; anthers creamy white, slightly tinged with pink; fruit subglobose to short-oblong, dark red.....C. amoena

Leaves ovate to oval, long-pointed; fruit subglobose, slightly 5-angled, bright red..... C. aristata

Leaves ovate; fruit broad-obovoid to short-oblong, green with a purple cheek..... C. prominens

Tube of the calyx of the fruit short; fruit pruinose

Leaves ovate

Fruit depressed-globose, green tinged with red or orange color.....C. gracilis
Fruit globose to depressed-globose, angular, becoming scarlet and lustrous.C. howeana
Fruit short-oblong, vermillion..C. latiflora
Fruit short-oblong to subglobose, often broader than high, dark red; anthers faintly tinged with pink .....C. pellecta
Leaves oblong-ovate; fruit short-oblong to oval, red .....C. ramosa
Leaves obovate; fruit subglobose, crimson..... C. scitula

Anthers yellow
Tube of the calyx of the fruit elongated
Leaves broadly ovate; fruit subglobose to short-oblong, crimson, lustrous.....C. conspecta
Leaves ovate to obovate; fruit obovoid, pale red, pruinose .....C. russata
Tube of the calyx of the fruit short
Leaves ovate; fruit pruinose
Fruit short-oblong to slightly obovoid, scarlet. C. formosa
Fruit obovoid, pruinose, green becoming dull crimson at maturity.....C. cognata
Leaves ovate to oval; fruit subglobose, often broader than high, to obovoid, orange-red, lustrous, flesh orange-red....C. rubro-lutea

‡‡ Fruit on stout erect pedicels; tube of the calyx of the fruit short
Anthers faintly tinged with pink; fruit obovoid
Leaves ovate to oval; fruit bright cherry-red, pruinose .....C. casta
Leaves broadly ovate; fruit dark green, becoming bright red and lustrous at maturity..... C. leiophylla
Anthers pale rose color; leaves ovate; fruit short-oblong, slightly angled, red, pruinose; calyx much enlarged .....C. macrocalyx
Anthers bright red; leaves ovate, acuminate; fruit subglobose, often broader than high, distinctly angled, orange-red, lustrous....C. clintoniana

Anthers yellow or white

Leaves ovate to oval; fruit subglobose, usually broader than high, conspicuously angled while young, pruinose, dull orange-red blotched with green at maturity.....C. conjuncta

Leaves oblong-ovate; fruit obovoid, gradually narrowed to the base, dark green tinged with red...
C. longipedunculata

†† Mature leaves scabrate on the upper surface

Leaves ovate to rhombic; anthers red; fruit ovoid to short-oblong, slightly pruinose, crimson; tube of the calyx of the fruit elongated.....C. lennoniana

Leaves ovate; anthers pink; fruit subglobose, often broader than high, bright apple green, slightly pruinose; tube of the calyx of the fruit short.....
C. bronxensis

** Stamens 10 or less

† Mature leaves smooth and glabrous on the upper surface

‡ Fruit on slender drooping pedicels, anthers rose color, red or maroon; tube of the calyx of the fruit short

Leaves ovate

Anthers slightly tinged with rose; fruit depressed-globose, broader than high, red, lustrous.....
C. uncta

Anthers dark red; fruit short-oblong, crimson, lustrous.....C. radiata

Anthers purplish red; fruit short-oblong to obovoid, bright orange-red, pruinose.....C. placiva

Leaves ovate to oval; anthers maroon; fruit short-oblong, cherry-red, pruinose.....C. pulchra

‡‡ Fruit on erect pedicels

Anthers rose color

Tube of the calyx of the fruit elongated; leaves ovate, acuminate; fruit obovoid, dark red, pruinose, hard and dry at maturity.....C. aridula

Tube of the calyx of the fruit short; leaves ovate; fruit depressed-globose, rather broader than high, dull red, slightly pruinose, becoming lustrous...
C. robbinsiana

Anthers pink

Leaves ovate to broadly ovate; fruit globose to depressed-globose, angular, scarcely pruinose, dull red, often blotched with red.....C. brevipes

Leaves oblong-obovate; fruit short-oblong, pruinose, light green, becoming crimson at maturity. C. plana

†† Mature leaves scabrate on the upper surface

‡ Fruit on slender drooping pedicels, pruinose

Leaves ovate; anthers rose color; fruit obovoid, scarlet .....C. ovatifolia

Leaves broadly ovate; anthers yellow; fruit short-oblong, dull greenish red.....C. inusitula

‡‡ Fruit on erect pedicels; leaves ovate; anthers dark rose color; fruit subglobose, often broader than high, scarlet, pruinose .....C. exornata

Medioximae

Leaves hairy on the upper surface early in the season, glabrous and smooth or scabrate at maturity; petioles long and slender; flowers in few- or many-flowered glabrous corymbs; stamens 10 or less, anthers rose color or pink; fruit globose, short-oblong or obovoid, rarely slightly angled, scarlet, crimson, maroon or orange-red, more or less pruinose, ripening late in September or in October, flesh hard and solid, mature calyx sessile, nutlets 2–5, usually 3 or 4.

* Fruit subglobose to globose

† Mature leaves smooth on the upper surface

‡ Leaves yellow-green

Leaves ovate to rhombic, acute or acuminate; fruit rather broader than high, crimson, blotched with green .....C. dissona

Leaves ovate to oval, acuminate and short-pointed; fruit subglobose to ovoid, crimson, pruinose..... C. implicata

Leaves broadly ovate

Calyx-lobes foliaceous, coarsely serrate; fruit obovoid at first, when fully grown becoming depressed-globose, bright red; leaves often truncate at the base .....C. deltoides

Calyx-lobes small, finely serrate; fruit subglobose, orange-red; leaves not truncate at the base..... C. seclusa

‡‡ Leaves blue-green

Leaves ovate to deltoid; fruit globose, dark scarlet, lustrous ..... C. maineana

Leaves oblong-ovate to oval; fruit rather broader than high to short-obovoid, obscurely angled, crimson, lustrous..... C. opulens

Leaves ovate-acuminate; fruit subglobose to short-oblong, truncate at the apex, rounded at the base, maroon, lustrous ..... C. perspicabilis

†† Mature leaves scabrate on the upper surface

Leaves yellow-green, ovate; fruit subglobose to short-oblong, scarlet, lustrous..... C. macera

Leaves blue-green, ovate-acuminate; fruit subglobose to short-oblong, flattened at the ends, scarlet, lustrous, slightly pruinose ..... C. diffusa

** Fruit short-oblong

† Mature leaves smooth on the upper surface

Leaves broadly ovate; calyx-lobes short and broad; anthers red; fruit orange-red, slightly pruinose.... C. xanthophylla

Leaves ovate; calyx-lobes long and slender; anthers bright rose color; fruit red and lustrous..... C. livingstoniana

†† Mature leaves scabrate on the upper surface, ovate, long-pointed; fruit scarlet, lustrous..... C. strigosa

*** Fruit obovoid

† Mature leaves glabrous on the upper surface

‡ Leaves blue-green above

Leaves subcoriaceous, oblong-ovate

Fruit oblong-obovoid or rarely short-oblong, light cherry red, pruinose ..... C. compta

Fruit full and rounded at the apex, abruptly narrowed at the base, bright orange-red, pruinose..... C. tortuosa

Leaves thin

Leaves oblong-ovate, acuminate; flowers in broad lax many-flowered corymbs; fruit oblong-obovoid, gradually tapering to the long base, crimson, lustrous.... C. promissa

Leaves ovate; flowers in compact 4–6-flowered corymbs; fruit only slightly narrowed at the base and sometimes decurrent on the pedicel.....C. congestiflora

‡‡ Leaves yellow-green above, thin
Anthers dark rose color
Calyx-lobes short and broad
Leaves oblong-ovate, long-pointed; flowers in 5–8-flowered corymbs; fruit abruptly narrowed and often mammillate at the base, scarlet, pruinose.. C. numerosa
Leaves oblong-ovate, acuminate; flowers in 8–12-flowered corymbs; fruit crimson, lustrous..... C. foliata
Calyx-lobes long and slender; leaves oblong-ovate, deeply tinged with red when they unfold; fruit crimson, lustrous .....C. colorata
Anthers pale pink; calyx-lobes long and narrow; leaves ovate; fruit scarlet, lustrous.....C. cruda
†† Mature leaves scabrate on the upper surface
‡ Leaves blue-green on the upper surface, ovate to rhombic; fruit crimson, pruinose, remaining hard at maturity.... C. acerba
‡‡ Leaves yellow-green on the upper surface
Leaves broadly ovate to triangular; anthers pale rose color; fruit on long slender drooping pedicels, light cherry-red, pruinose..... C. dissociabilis
Leaves broadly ovate; anthers purple; fruit on stout erect or spreading pedicels, crimson, pruinose .....C. barryana

Tenuifoliae

Leaves thin, hairy on the upper surface early in the season, becoming smooth or scabrate; petioles long and slender; flowers in glabrous or slightly villose corymbs; stamens 10 or less, or rarely 20, anthers rose color or pink; fruit short-oblong, subglobose or obovoid, red, lustrous, ripening in August or September, the flesh soft and succulent, mature calyx small and sessile.
* Stamens 10 or less
† Fruit longer than broad
‡ Fruit usually short-oblong
Leaves yellow-green above
Upper surface of mature leaves glabrous
Leaves ovate, acuminate

Calyx-lobes villose on the inner surface.
Leaves oblong-ovate; flowers in 6–12-flowered corymbs; pedicels and calyx-tube glabrous.. C. ignea
Leaves broadly ovate; flowers in 15–18-flowered corymbs; pedicels and calyx-tube slightly villose .....C. hadleyana
Calyx-lobes glabrous on the inner surface
Fruit bright orange-red
Anthers dark rose color; cavity of the fruit deep and narrow.....C. suavis
Anthers pink
Flowers not more than 1.2 cm in diameter, in narrow compact corymbs; cavity of the fruit broad and shallow..... C. boothiana
Flowers 1.5–1.6 cm in diameter, in broad lax corymbs; fruit sometimes slightly obovoid, the cavity deep and narrow.. C. slavinii
Fruit dark crimson, lustrous, oblong-obovoid early in the season, becoming short-oblong; anthers pink .....C. ascendens
Fruit crimson, sometimes subglobose; anthers dark red; leaves long-pointed..... C. acuminata
Fruit sometimes slightly obovoid
Flowers in wide lax many-flowered corymbs
Anthers dark rose color; fruit bright scarlet, its cavity small and shallow..... C. tenella
Anthers pale rose color; fruit crimson, its cavity deep and narrow..... C. spathifolia
Flowers in small compact corymbs; anthers pink; fruit scarlet, lustrous...C. nescia
Leaves ovate, acute; fruit rarely subglobose, the flesh red; anthers purple..C. rubrocarnea
Leaves broadly ovate, acute, glaucescent early in the season; anthers dark rose colored; fruit scarlet, lustrous.....C. glaucophylla

Leaves ovate to deltoid, acute; anthers rose colored; fruit sometimes slightly obovoid..... C. demissa

Leaves ovate to broadly oval, acute; anthers light red; fruit scarlet, lustrous.....C. delucida

Leaves ovate to rhombic or ovate-oblong; anthers red; fruit dark purple-red, ripening and falling in August .....C. matura

Upper surface of the mature leaves scabrate

Leaves ovate, acuminate

Calyx-lobes slightly villose on the inner surface; fruit scarlet, lustrous

Calyx and pedicels glabrous; leaves dark green; flesh of the fruit dry and yellow .....C. streeterae

Calyx and pedicels slightly hairy; leaves light green; flesh of the fruit juicy and red.....C. rubicunda

Calyx-lobes glabrous on the inner surface

Anthers light rose color

Fruit scarlet, lustrous; flowers up to 1.8 cm in diameter.....C. recta

Fruit dull red; flowers about 1.5 cm in diameter .....C. insignata

Anthers dark rose color; fruit crimson.... C. fucata

Leaves oval to ovate, acute; fruit dark crimson, lustrous; stamens rarely more than five..... C. pentandra

Leaves blue-green above, glabrous at maturity

Leaves ovate, acuminate; fruit scarlet, lustrous; anthers rose color

Cavity of the fruit broad and deep; flesh of the fruit thick, sweet and juicy.....C. bella

Cavity of the fruit narrow and shallow; flesh of the fruit thin, dry and mealy....C. ornata

Leaves oval, acute or acuminate; anthers rose color; fruit crimson, lustrous.....C. genialis

‡‡ Fruit obovoid

Leaves yellow-green

Upper surface of the mature leaves glabrous

Leaves oblong-ovate, long-pointed, narrowed at the base; anthers dark red; fruit cherry-red, 1–1.2 cm long.....C. leptopoda

Leaves ovate, acuminate, often broad at the base; anthers rose color; fruit scarlet, 2.5 cm long.. C. paineana

Upper surface of the mature leaves scabrate

Leaves ovate, acuminate; fruit scarlet, the calyx little enlarged; anthers light red..... C. gracilipes

Leaves ovate, acute; fruit crimson, the calyx much enlarged and prominent; anthers dark rose color .....C. habereri

Leaves blue-green above, glabrous at maturity

Leaves oblong-ovate to oval, acuminate, thick; flowers not more than 1 cm in diameter, in wide many-flowered corymbs; stamens usually 5, anthers pink; fruit crimson, lustrous..... C. parviflora

Leaves broadly ovate, acuminate, thin; flowers 1.5 cm in diameter, in narrow usually 4–6-flowered corymbs; stamens 10, anthers dark rose color; fruit scarlet, lustrous.....C. tenuiloba

†† Fruit subglobase; leaves yellow-green

Leaves scabrate on the upper surface, deeply lobed..... C. claytoniana

Leaves glabrous on the upper surface, slightly lobed.... C. stolonifera

** Stamens 20

† Fruit usually short-oblong

Leaves yellow-green and glabrous on the upper surface at maturity

Leaves oblong-ovate to oval, acuminate; flowers in compact 7–8-flowered corymbs; anthers pink; fruit on drooping pedicels, occasionally obovoid, bright cherry-red, lustrous.....C. edsonii

Leaves broadly ovate, acuminate; anthers rose color; fruit on erect pedicels, orange-red, lustrous..... C. conferta

Leaves blue-green and scabrate on the upper surface at maturity, ovate, acuminate

Flowers in wide lax many-flowered corymbs; anthers red; fruit on long drooping pedicels, dull scarlet, its cavity shallow and narrow.....C. benigna

Flowers in compact 6–12–flowered corymbs; anthers light red; fruit sometimes slightly obovoid, on short erect pedicels, its cavity deep and narrow..... C. mellita

†† Fruit obovoid, dark crimson, lustrous; leaves oblong-ovate, acuminate, yellow-green, flabrous at maturity; anthers dark red.....C. luminosa

Coccineae

Leaves large, thin, oblong, acutely and more or less deeply lobed; petioles long; flowers in usually wide many-flowered corymbs; stamens 10 or less, or 20; anthers rose color, pink or rarely white; fruit short-oblong to obovoid, up to 2 cm in length, flesh succulent, nutlets 3–5, grooved and usually ridged on the back (*Flabellatae* Sargent in Rhodora 111.22 [1901]).

* Anthers rose color or pink

† Stamens 10 or less

‡ Fruit short-oblong

Leaves glabrous on the upper surface at maturity

Stamens usually 5; fruit on long slender pedicels

Calyx-tube glabrous; leaves ovate to oval, acute; anthers dark red.....C. holmesiana

Calyx-tube villose

Leaves oblong-ovate, acuminate; calyx-tube densely covered with matted hairs, the lobes long and slender, villose on the inner surface; anthers pink.....C. acclivis

Leaves ovate, acute or acuminate; calyx-tube slightly hairy, the lobes short and broad, glabrous; anthers rose color....C. uticaënsis

Stamens usually 10; fruit on short stout pedicels

Leaves ovate, acute, drooping, conspicuously concave; fruit dark dull red, villose at the ends..... C. pringlei

Leaves oval to oblong-ovate; fruit crimson, lustrous, glabrous .....C. lobulata

Leaves scabrate on the upper surface at maturity

Leaves broadly ovate to oval, acute or acuminate; stamens usually 10; anthers rose color; fruit rounded and symmetrical at the base..... C. pedicellata

Leaves ovate, acuminate; stamens 8–10; anthers pale pink; fruit usually unsymmetrical at the base by a mammillate process adnate to the pedicel..... C. gloriosa

‡‡ Fruit obovoid

Leaves glabrous on the upper surface at maturity, ovate, acute or acuminate; stamens 10, anthers pink..... C. letchworthiana

Leaves scabrate on the upper surface at maturity

Leaves oblong-ovate, acuminate; stamens 10, anthers pale pink ..... C. vivida

Leaves oval to oblong-ovate, short-pointed and acute at the apex; stamens 5–8, anthers dark rose color.. C. tardipes

‡‡‡ Fruit subglobose to short-oblong or rarely obovoid, on erect pedicels; leaves glabrous on the upper surface at maturity, ovate to oval, acute or acuminate; stamens usually 5, anthers rose purple..C. polita

‡‡‡‡ Fruit subglobose to oval; leaves scabrate on the upper surface at maturity, ovate, acuminate; stamens 7–10, anthers rose color..C. sejuncta

†† Stamens 20

‡ Leaves glabrous on the upper surface at maturity.

Leaves broadly ovate, acuminate; fruit gradually narrowed to the base and often slightly decurrent on the pedicel.

Leaves yellow-green; calyx-tube glabrous; anthers pink ..... C. dayana

Leaves blue-green; calyx villose; anthers red..... C. gilbertiana

Leaves ovate, long-pointed, deeply lobed; corymbs densely villose; anthers pink....C. flabellata

‡‡ Leaves scabrate on the upper surface at maturity.

Leaves ovate, long-pointed and acuminate; anthers pale rose color; fruit abruptly narrowed at the base. C steubenensis

Leaves oblong-ovate, acuminate, slightly lobed; corymbs only sparingly villose; anthers red..... C. limosa

** Anthers white

Stamens 20; calyx and pedicels densely villose..C. irrasa

Stamens 5–8; calyx and pedicels slightly villose..... C. perrara

Molles

Leaves thin, broad, cuneate or rounded at the base, petioles long; flowers large, in many-flowered corymbs; stamens 10 or less, or 15–20, anthers yellow, rose color or pink; fruit up to 2.5 cm in diameter, subglobose or obovoid, scarlet, more or less pubescent at the ends; nutlets 3–5, narrow at the ends, only slightly ridged.

* Stamens 10 or less

† Anthers yellow

Fruit obovoid to short-oblong, on erect pedicels; leaves blue-green and glabrous on the upper surface at maturity . . . . . C. champlainensis

Fruit subglobose to short-oblong, on drooping pedicels; leaves yellow-green and scabrate on the upper surface at maturity, their margin more or less contorted..... C. contortifolia

†† Anthers rose color; leaves yellow-green at maturity

Leaves scabrate on the upper surface at maturity

Flowers in wide many-flowered corymbs; leaves oval; fruit short-oblong, crimson..C. ellwangeriana

Flowers in very compact few-flowered corymbs; leaves oblong-ovate; fruit short-oblong to oblong-obovoid, scarlet.....C. robesoniana

Leaves glabrous on the upper surface at maturity

Flowers in wide corymbs; leaves ovate; fruit short-oblong to obovoid, bright cherry-red..C. exclusa

Flowers in compact corymbs; leaves oblong-ovoid; fruit subglobose to short-oblong, dark crimson..... C. urbica

Flowers in broad loose many-flowered villose corymbs; leaves ovate; fruit obovoid to short-oblong, crimson.. C. anomala

††† Anthers pink; leaves blue-green and glabrous on the upper surface at maturity; fruit obovoid, bright scarlet.... C. huntiana

** Stamens 15–20; anthers rose color; leaves oval to ovate, yellow-green and scabrate above at maturity; fruit short-oblong, crimson .....C. radians

*** Stamens 20; anthers rose color; leaves ovate to oval, yellow-green and usually scabrate above at maturity; fruit short-oblong .....C. fulleriana

Dilatatae

Leaves thin, wide, often broader than long on vigorous shoots, petioles long and slender; flowers large, in broad 6–12-flowered corymbs; stamens 20, anthers rose color; fruit subglobose, the calyx enlarged and prominent; nutlets 5, ridged on the back.

* Leaves truncate or cordate at the wide base, broadly ovate; fruit bright scarlet.....C. dilatata

** Leaves cuneate at the base; fruit crimson

Leaves ovate to slightly obovate; fruit ripening early in September and soon falling, its cavity deep..... C. hudsoniana

Leaves ovate; fruit ripening late in October and persistent until midwinter, its cavity shallow..... C. durobrivensis

Intricatae

Leaves thin, usually cuneate at the base, petioles short, glandular; flowers large, opening late, in small few-flowered glandular corymbs, with large conspicuous bracts and bractlets; stamens 10 or less in the New York species, anthers yellow, pink or rose color; fruit late ripening, usually short-oblong or obovoid, red or yellow, flesh hard; nutlets 3–5, rounded at the ends.

* Anthers yellow

Fruit obovoid; mature leaves glabrous above

Leaves oblong-ovate, acuminate; fruit dark orange-red.....C. intricata

Leaves oval — acuminate to ovate — acute; fruit pale orange-yellow .....C. cornellii

Fruit short-oblong to obovoid, crimson; leaves oblong to obovate, scabrate on the upper surface at maturity. C. verecunda

Fruit subglobose to short-oblong or obovoid, green, yellow or orange, villose at the ends; leaves ovate, scabrate on the upper surface at maturity..... C. modesta

Fruit subglobose, orange-red; leaves oblong-ovate to oval, glabrous on the upper surface at maturity..... C. foetida

** Anthers pink or pale rose color

Fruit obovoid, dull orange-red tinged with green, on drooping pedicels; leaves oval to ovate, glabrous.... C. bissellii

Fruit subglobose to short-oblong or ovoid, yellow-green, tinged with red, villose at the ends, on erect pedicels; leaves oblong-ovate, scabrate on the upper surface at maturity..... C. peckii

Rotundifoliae

Leaves subcoriaceous or thin, obovate to ovate, elliptical or rhombic, cuneate at the base, petioles usually short; flowers in many- or few-flowered corymbs; stamens 10 or less, or 15–20, anthers yellow, white, rose color or pink; fruit subglobose to short-oblong or obovoid, red, generally ripening late, mostly 1–1.5 cm in diameter; nutlets usually 3 or 4 (*Coccineae* Sargent in Rhodora 3:26 (not Loudon) (1901).

* Anthers yellow or white

† Stamens 10 or less

Leaves subcoriaceous; flowers in glabrous or in villose corymbs (var. pubera); fruit short-oblong, up to 1.5 cm in diameter..... C. rotundifolia

Leaves thin

Leaves smooth and glabrous; corymbs glabrous; fruit short-oblong, usually less than 1 cm in diameter... C. dodgei

Young leaves roughened above by short hairs; corymbs villose, fruit obovoid.... C. caesariata

†† Stamens 10–18; leaves thin; flowers in compact villose corymbs; fruit short-oblong to subglobose, scarlet.... C. divergens

††† Stamens usually 20

‡ Upper surface of the mature leaves smooth

Flowers in villose corymbs; anthers white; fruit ellipsoidal to subglobose, bright cherry-red..... C. illuminata

Flowers in glabrous corymbs; fruit short-oblong, crimson

Leaves thick, elliptical to obovate or ovate, roughened above while young by short hairs; flowers in wide many-flowered corymbs; anthers white.. C. maribella

Leaves thin, rhombic to obovate, glabrous above; flowers in narrow few-flowered corymbs; anthers yellow . . . . . C. macauleyae

‡‡ Upper surface of the mature leaves scabrate; flowers in villose corymbs; stamens 15–20; leaves broadly ovate, deeply lobed; fruit short-oblong to subglobose, crimson . . . . . C. noveboracensis

** Anthers rose color, red or pink

† Stamens 10 or less

‡ Corymbs villose; leaves roughened above while young by short hairs

Flowers in small compact 4–10-flowered corymbs; fruit subglobose to short-oblong

Stamens 5–10, anthers red; fruit scarlet; leaves ovoid to obovoid..... C. verrucalis

Stamens 5–7, anthers dark rose color; fruit short-oblong, orange-red; leaves rhombic to obovate... C. puberis

Stamens 10, anthers pale pink; fruit crimson; leaves ovate . . . . . C. proctoriana

Flowers in wide many-flowered corymbs; stamens 5–10, anthers pink

Fruit short-oblong, ripening at the end of September, its cavity deep, pointed in the bottom; leaves elliptical to slightly obovate..... C. maligna

Fruit subglobose, ripening in August, its cavity shallow, broad in the bottom; leaves rhombic... C. praecoqua

‡‡ Corymbs usually glabrous

Leaves roughened above by short white hairs; fruit subglobose to ellipsoidal, scarlet

Flowers in small very compact 5–10-flowered corymbs; stamens 10, anthers pink..... C. spissa

Flowers in wide mostly 10–15-flowered corymbs; stamens 5, anthers dark rose color..... C. chateaugayensis

Young leaves covered above by soft hairs; flowers in wide 7–15-flowered corymbs; stamens 5 or 6; anthers pink; fruit short-oblong to slightly obovoid, cherry-red.....C. harryi

†† Stamens 20, anthers pink; leaves thin, glabrous; flowers in wide 7–10-flowered glabrous corymbs; fruit short-oblong, dark red.....C. neo-baxteri

Anomalae

Leaves thick to subcoriaceous, usually cuneate or on vigorous shoots narrowed and rounded or rarely cuneate or subcordate at the base, scabrate above while young; petioles long and slender; flowers in many-flowered glabrous or villose corymbs; stamens 10 or 20, anthers rose color or pink; fruit subglobose to short-oblong or rarely obovoid, nutlets furnished with obscure ventral depressions.

* Stamens 20

† Flowers on villose pedicels; leaves ovate to oval or obovate, villose on midribs and veins below; anthers rose color; fruit short-oblong to ovoid or depressed-globose, orange-red, cavity of the fruit broad..... C. saundersiana

†† Flowers on glabrous pedicels; leaves glabrous below; cavity of the fruit narrow

Leaves ovate to oval; calyx-lobes glabrous on the inner surface; anthers pink; fruit short-oblong to obovoid, orange-red.....C. brachyloba

Leaves obovate to ovate; calyx-lobes villose on the inner surface; anthers rose color; fruit subglobose, scarlet.....C. fallsiana

** Stamens 10 or less

† Leaves scabrate on the upper surface at maturity

‡ Fruit subglobose; pedicels and inner surface of the calyx-lobes villose

Leaves broadly ovate to oval or suborbicular, acute; fruit often broader than high, crimson..... C. dunbarii

Leaves oblong-ovate, acuminate; fruit dark red..... C. inopinata

‡‡ Fruit short-oblong

Pedicels and inner surface of the calyx-lobes glabrous; leaves oblong-obovate, acuminate. C. scabrida

Pedicels and inner surface of the calyx-lobes villose

Leaves rhombic to broadly obovate, short-acuminate ..... C. affinis

Leaves rhombic to obovate, acuminate..... C. misella

Leaves oblong-ovate, acuminate..... C. asperifolia

‡‡‡ Fruit short-oblong to obovoid, bright red; pedicels and inner surface of the calyx-lobes villose..... C. repulsans

†† Leaves glabrous on the upper surface at maturity; pedicels glabrous; inner surface of the calyx-lobes villose

Leaves oblong-ovate, long-pointed, finely serrate, on vigorous shoots gradually narrowed and cuneate at the base; anthers dark red or purple; fruit narrow-obovoid ..... C. floridula

Leaves ovate, acuminate, coarsely serrate, on vigorous shoots broad, rounded, subcordate or rarely cuneate at the base; anthers rose color; fruit short-oblong.... C. knieskerniana

Tomentosae

Leaves thin or subcoriaceous; flowers small, opening late, in many-flowered tomentose, villose or rarely glabrous corymbs; stamens usually 10 or 20; fruit obovoid to subglobose or short-oblong, becoming soft and succulent at maturity; nutlets 2 or 3, obtuse at the ends, penetrated on their inner faces by longitudinal cavities

* Leaves thin

† Stamens usually 20

‡ Anthers rose color or pink

Fruit obovoid, orange-red; leaves oval to ovate-oblong; anthers pale rose color.. C. tomentosa

Fruit usually subglobose

Mature leaves more or less villose below

Anthers rose color

Leaves oblong-ovate to rhombic, smooth above while young; corymbs and calyx nearly glabrous; fruit scarlet..... C. efferta

Leaves oblong-obovate, scabrate above while young; fruit sometimes slightly obovoid, crimson ..... C. diversa

Anthers pink

Leaves rhombic to oblong-ovate; fruit short-oblong to subglobose, orange-red ..... C. finitima

Leaves ovate to obovate; fruit sometimes slightly obovoid, scarlet .... C. spinifera

Mature leaves glabrous, elliptic to rhombic or rarely obovate; fruit scarlet; anthers red ..... C. menandiana

‡‡ Anthers pale yellow

Mature leaves more or less villose below

Fruit short-oblong to obovoid, orange-scarlet; leaves oblong-ovate to oval or obovate .. C. structilis

Fruit short-oblong to subglobose, orange-red, covered with short pale hairs; leaves ovate to rhombic .... C. comans

Fruit subglobose, dark red; leaves obovate ..... C. truculenta

Mature leaves glabrous, ovate to elliptic or subrhombic; fruit short-oblong, crimson ..... C. ambrosia

†† Stamens 10 or less

‡ Anthers rose color or pink; fruit subglobose to short-oblong

Mature leaves villose below, rhombic to obovate, acute or acuminate; fruit on erect pedicels, bright red; anthers purple ..... C. rhombifolia

Mature leaves glabrous below

Fruit on drooping pedicels, scarlet

Leaves ovate, long-pointed; anthers dark rose color; cavity of the fruit deep and narrow ..... C. deweyana

Leaves obovate to rhombic; anthers pink; cavity of the fruit broad and shallow ..... C. cupulifera

Fruit on erect pedicels, orange-red; leaves obovate to rhombic; anthers pink ..... C. balkwillii

‡‡ Anthers pale yellow; fruit subglobose

Fruit on drooping pedicels
Leaves obovate to ovate or oval; fruit crimson; flowers up to 1.5 cm in diameter, on slightly hairy pedicels .....C. microsperma
Leaves oblong-ovate to oval; fruit dark crimson; flowers not more than 1.2 cm in diameter, on densely villose pedicels.....C. flagrans
Fruit on erect pedicels
Leaves oblong-ovate; fruit crimson; flowers on glabrous pedicels .....C. venustula
Leaves oval to oblong-obovate; fruit dark orange-red; flowers on densely villose pedicels.....
C. laneyi

** Leaves thick
† Stamens usually 20
‡ Anthers pale rose color or pink
Fruit on long drooping pedicels, scarlet
Leaves elliptical, acute at the ends; fruit subglobose .....C. succulenta
Leaves broadly oval to obovate, acute or rounded at the apex; fruit subglobose to short-oblong.....
C. gemmosa
Leaves rhombic to oval or ovate, acute or acuminate; fruit ovoid to oval.....C. calvinii
Leaves obovate, acute; fruit short-oblong to subglobose; anthers pink.C. sonnenbergensis
Fruit on erect pedicels
Corymbs and under surface of the leaves villose
Fruit scarlet
Leaves obovate; fruit short-oblong.....
C. frutescens
Leaves oval to ovate or obovate; fruit short-oblong to ovate.....C. honeoyensis
Fruit bright cherry-red, subglobose to short-oblong or ovate .....C. admiranda
Corymbs and under surface of the leaves glabrous; leaves rhombic; fruit short-oblong to subglobose.
C. spinea
‡‡ Anthers pale yellow; leaves oblong-obovate to oval; fruit on drooping pedicels, subglobose, crimson.....
C. halliana

†† Stamens 10–20; anthers pink; leaves oblong-obovate; tomentose below at maturity; fruit on drooping pedicels, subglobose to short-oblong, crimson..C. conspicua

††† Stamens 10 or less

‡ Anthers rose color or pink; leaves ovate to obovate; fruit on drooping pedicels, crimson

Young leaves glabrous above; anthers rose color; fruit subglobose to obovoid, cavity of the calyx deep .....C. beckiana

Young leaves covered above by short white hairs; anthers pale pink; fruit subglobose, cavity of the calyx shallow.....C. ogdensburgensis

‡‡ Anthers pale yellow

Fruit on drooping pedicels, subglobose to short-oblong; spines stout

Leaves rhombic or oval or obovate, short-pointed or rounded at the apex.....C. ferentaria

Leaves broadly ovate to slightly obovate, acute....
C. hystricina

Fruit on erect pedicels, subglobose, crimson, not more than 1 cm in diameter; spines long and slender; leaves broadly obovate to elliptic or oval.....
C. macracantha

List of species

CRUS-GALLI

Crataegus crus-galli Linnaeus

Spec. 476 (1753). Sargent, Silva N. Am. IV. 91, t. 178

Near Albany and Hemlock lake region; not common.

Var. pyracanthifolia Aiton, Hort. Kew. II. 170 (1788)

Rochester, Niagara Falls and La Salle; not common.

Var. rubens n. var.

Anthers white faintly tinged with pink; flesh of the fruit red, otherwise as in the species.

On the rich bottom lands bordering the outlet of Canandaigua lake east of the railroad station at Chapin, Ontario county; very common.

B. H. Slavin (no. 3, type), September 24, 1908, June 14, 1909; (no. 54), September 24, 1908; June 14, 1909.

Crataegus arduennae Sargent

Bot. Gazette XXXV. 377 (1903); N. Y. State Mus. Bul. 122. 27 (1908)

South Buffalo; not common; also eastern Pennsylvania and Ontario to Illinois and Missouri.

Crataegus geneseensis Sargent

N. Y. State Mus. Bul. 122. 27 (1908)

Valley of the Genesee river.

Crataegus robusta Sargent

N. Y. State Mus. Bul. 122. 28 (1908)

Niagara Falls.

Crataegus cerasina Sargent

N. Y. State Mus. Bul. 122. 29 (1908)

Niagara Falls.

Crataegus persimilis Sargent

Proc. Rochester Acad. Sci. IV. 94. (1903)

Near Rochester and Syracuse.

Crataegus helderbergensis Sargent

N. Y. State Mus. Bul. 105. 49 (1906)

Thompson lake, near Albany.

PUNCTATAE

Crataegus punctata Jacquin

Hort. vind. 1. 10, t. 28 (1770). Sargent, Silva N. Am. IV. 103, t. 184

Very common.

Var. aurea Aiton, Hort. Kew. 11. 170 (1780).

Common.

Var. canescens Britton, Bul. Torrey Bot. Club XXI. 231 (1894).— Sargent, N. Y. State Mus. Bul. 105. 50 (1906).

North Greenbush; rare.

Crataegus celsa Sargent

N. Y. State Mus. Bul. 122. 31 (1908)

Niagara Falls.

Crataegus notabilis Sargent

N. Y. State Mus. Bul. 122. 32 (1908)

Buffalo.

Crataegus eastmaniana n. sp.

Glabrous. Leaves obovate and cuneate at the base to ovate and rounded at the base, sharply serrate and slightly divided above the middle into small acuminate lobes; nearly fully grown when the flowers open during the first week of June and then thin, yellow-green above and glaucescent below, and at maturity thin, dark blue-green and lustrous on the upper surface and paler on the lower surface, 4.5 to 5 cm long and 3 to 4 cm wide, with prominent midribs and primary veins; turning orange and red in October; petioles slender, slightly wing-margined at the apex, 1.5–2.5 cm in length; leaves on vigorous shoots broadly ovate, rounded or cuneate at the base, more coarsely serrate and more deeply lobed, and often 6 to 7 cm long and 5 to 6 cm wide. Flowers 2.5 cm in diameter on slender pedicels, in small compact five- to ten-flowered corymbs, the lower peduncles from the axils of upper leaves; calyx-tube broadly obconic, the lobes separated by wide sinuses, slender, acuminate, nearly entire, occasionally glandular-serrate near the middle, reflexed after anthesis; stamens twenty; anthers dark rose color, soon fading to light green; styles three to five, surrounded at the base by a narrow ring of pale tomentum. Fruit ripening early in October on slender drooping pedicels, short-oblong to slightly obovoid, dark crimson, slightly pruinose, marked by numerous small pale dots, about 1.5 cm long and 1.2 cm in diameter; calyx little enlarged, with a deep narrow cavity pointed and densely tomentose in the bottom, and spreading usually incurved persistent lobes; flesh thin, dry and mealy; nutlets three to five, rounded at the base, narrowed and rounded at the apex, ridged on the back with a broad high ridge, 9 to 10 mm long and 5 to 6 mm wide, the narrow hypostyle extending nearly to the middle of the nutlet.

An arborescent shrub 5 to 7 m high, with a short main stem sometimes 3 cm in diameter, smooth pale gray branches, and slender nearly straight branchlets dark yellow-green when they first appear, light orange-brown at the end of their first season, and gray-brown the following year, and armed with numerous slender straight or slightly curved chestnut-brown shining spines 2.5 to 3.5 cm long.

Low rich ground on the border of Durand-Eastman park, Rochester, Henry T. Brown (no. 1, type), October 6, 1908; June 7, 1909.

Crataegus dewingii Sargent

N. Y. State Mus. Bul. 122. 34 (1908).

Buffalo, Belfast.

Crataegus eatoniana Sargent

N. Y. State Mus. Bul. 105. 51 (1906).

Menands near Albany.

Crataegus barbara Sargent

N. Y. State Mus. Bul. 122. 33 (1908).

Brighton near Rochester.

Crataegus pausiaca Ashe

Ann. Carnegie Mus. 1. 390 (1902). Sargent, Trees and Shrubs 1. 105. t. 53.

Chapin; also in eastern Pennsylvania.

Crataegus desueta Sargent

N. Y. State Mus. Bul. 122. 84 (1908).

Coopers Plains and Olean.

Crataegus brownietta n. sp.

Leaves obovate to ovate, acute, cuneate or rounded at the base, finely and often doubly serrate with straight glandular teeth, and slightly divided above the middle into short acuminate spreading lobes; nearly fully grown when the flowers open in the last week of May and then yellow-green, roughened above by short white hairs and sparingly villose on the midribs and veins below, and at maturity thin, dark yellow-green and glabrous on the upper surface, still slightly villose on the lower surface, 4 to 4.5 cm long and 2.5 to 3 cm wide, with slender midribs and four or five pairs of thin primary veins; petioles slender, slightly wing-margined at the apex, sparingly villose early in the season, becoming glabrous, and more or less tinged with red in the autumn, 1 to 1.5 cm in length; leaves on vigorous shoots broadly ovate, acuminate, rounded at the wide base, subcoriaceous, coarsely serrate, deeply lobed, often 7 to 8 cm long and wide, with stout winged petioles. Flowers on slender slightly hairy pedicels, in wide lax many-flowered sparingly villose corymbs, the lower peduncles from the axils of upper leaves; calyx-tube narrowly obconic, glabrous, the lobes long, slender, acuminate, usually glandular-serrate below the middle, glabrous on the outer, slightly villose on the inner surface, reflexed after anthesis; stamens ten; anthers bright pink; styles three or four, surrounded at the base by a broad ring of long white hairs. Fruit ripening the end of

September on glabrous drooping red pedicels, subglobose to slightly obovoid, crimson, lustrous, marked by numerous small pale dots, 1.5 cm in diameter; calyx prominent with a broad shallow cavity pointed and tomentose in the bottom, and spreading and incurved lobes; flesh thin, yellow, dry and mealy; nutlets three or four, rounded and broadest at the apex, gradually narrowed and rounded at the base, prominently ridged on the back with a broad high ridge, 8 to 9 mm long and about 5 mm wide, the narrow chestnut-brown hypostyle extending to below the middle of the nutlet.

A tree or arborescent shrub 6 to 7 m high, with a stem covered with yellowish brown bark, upright branches, and slender nearly straight branchlets dark orange-green marked by pale lenticels and slightly villose when they first appear, glabrous, lustrous and light gray-green at the end of their first season and dull gray-brown the following year, and armed with stout straight chestnut-brown shining spines 3 to 5 cm long.

Helmlock lake region, Livingston county, Henry T. Brown (no. 31, type), May 28, 1906; September 20, 1907.

This species is named for its discoverer, Henry T. Brown, the engineer of the park department of the city of Rochester who has paid particular attention to the Thorns which grow in great abundance and variety near Hemlock lake.

PRUINOSAE

Crataegus pruinosa K. Koch

Verhandl. Preuss. Gart. Verein. neue Reihe 1. 346 (1854). Sargent, Silva N. Am. XIII. 61, t.648; N. Y. State Mus. Bul. 122. 37 (1908).

Crown Point, Lansingburg, Chapin, Buffalo, Belfast, Salamanca; also western Vermont, Massachusetts, eastern Pennsylvania, and southern Ontario to Ohio and Illinois.

Crataegus oblita Sargent

N. Y. State Mus. Bul. 122. 40 (1908).

Buffalo.

Crataegus arcana Beadle

Biltmore Bot. Studies 1. 122 (1902). Sargent, Bot. Gazette XXXV. 101; N. Y. State Mus. Bul. 122. 35 (1908).

Syracuse, Niagara Falls, Coopers Plains; also eastern Pennsylvania to western North Carolina.

Crataegus obstipa n. sp.

Glabrous. Leaves rhombic, acute at the ends, finely serrate with straight glandular teeth and slightly divided above the middle into two or three pairs of short, broad lobes; about one-half grown when the flowers open early in June and then yellow-green and paler below than above, and at maturity thin, yellow-green, smooth and lustrous on the upper surface, pale on the lower surface, 4 to 4.5 cm long and 2.5 to 3 cm wide, with thin midribs and primary veins; petioles slender, narrowly wing-margined to the middle, 4.5 to 6 cm in length; stipules linear, glandular, bright red, deciduous before the flowers open; leaves on vigorous shoots thicker, more coarsely serrate and more deeply lobed, and sometimes 5 cm long and 4 cm wide. Flowers on slender pedicels, in five- or six-flowered corymbs, the lower peduncles from the axils of upper leaves; calyx-tube broadly obconic, the lobes separated by wide sinuses, gradually narrowed from the base, slender, acuminate, entire or minutely glandular-dentate near the middle; stamens twenty; anthers maroon; styles three to five. Fruit ripening early in October on slender drooping pedicels, obconic, rounded at the apex and at the narrow base, crimson, marked by large pale dots, pruinose, 1.3–1.5 cm long and 1 to 1.2 cm in diameter; calyx prominent, with a short tube, a deep narrow cavity pointed in the bottom, and spreading erect lobes; flesh thin, hard and dry; nutlets three to five, thin and rounded at the ends, broader at the apex than at the base, ridged on the back, with a broad, grooved ridge, 6 to 7.5 mm long and 5 mm wide, the narrow hypostyle extending to just below the middle of the nutlet.

A shrub 3 or 4 m high, with ascending stems and branches covered with dark gray bark, and thin zigzag contorted branchlets dark green and marked by pale lenticels when they first appear, orange-brown at the end of their first season and dull gray-brown the following year, and armed with very numerous straight chestnut-brown shining spines 1.5 to 3 cm long, persistent and compound on old stems and branches.

Open pastures in heavy soil, near Chapin, Ontario county, B. H. Slavin (no. 21, type), October 3, 1908; May 29, 1909.

Crataegus beata Sargent

Proc. Rochester Acad. Sci. IV. 97 (1903); N. Y. State Mus. Bull. 122. 85 (1908).

Ithaca, Chapin, near Rochester, Hemlock lake, Canadice lake, Belfast, Portage, Castile, Coopers Plains; common.

Crataegus pallescens n. sp.

Glabrous with the exception of the hairs on the young leaves and calyx-lobes. Leaves ovate, acuminate, rounded or abruptly cuneate at the broad base, sharply and often doubly serrate with straight glandular teeth, and divided into five or six pairs of short acuminate spreading lobes; more than half-grown when the flowers open the middle of June and then thin, yellow-green, and covered above by short white hairs and glabrous and glaucescent below, and at maturity thin, glabrous, dark yellow-green on the upper surface and pale on the lower surface, 6.5 to 8.5 cm long and 6 to 8 cm wide, with thick midribs and thin primary veins arching obliquely to the points of the lobes; petioles slender, broadly wing-margined at the apex, glandular with conspicuous occasionally persistent glands, 2.5 to 3.5 cm in length; stipules strap-shaped, acute, bright rose color, conspicuously glandular, often persistent until the flowers open; leaves on vigorous shoots abruptly cuneate at the base, more coarsely serrate and more deeply lobed, and sometimes 9 to 10 cm long and broad. Flowers 2.5 cm in diameter on long slender pedicels, in compact mostly ten- to fifteen-flowered corymbs, the lower peduncles from the axils of upper leaves; calyx-tube broadly obconic, the lobes separated by wide sinuses, long, wide, acuminate, conspicuously glandular-serrate, slightly villose on the inner surface, reflexed after anthesis; stamens ten; anthers deep red; styles four or five. Fruit ripening early in October on drooping red pedicels, short-oblong, rounded at the ends, cardinal-red, marked by occasional large pale dots, pruinose, 1 to 1.2 cm in diameter; calyx prominent, with a short tube, a wide, deep cavity pointed in the bottom, and spreading prominent lobes; flesh thin, yellow, dry and mealy; nutlets four or five, gradually narrowed to the ends, rather broader at the apex than at the base, irregularly ridged on the back with a high narrow ridge, 7 to 8 mm long and 4 to 4.5 mm wide, the broad hypostyle extending one-third the length of the nutlet.

An arborescent shrub 6 to 7 m tall, with stems sometimes 3 cm in diameter at the base, covered with dull ashy gray bark, ascending and spreading branches forming a thin open head, and stout slightly zigzag branchlets dark orange-green and marked by pale lenticels when they first appear, becoming pale chestnut-brown and lustrous at the end of their first season and armed with occasional stout slightly curved chestnut-brown shining spines 4 to 5 cm long and sometimes persistent and compound on old stems and branches.

Open damp woods near Ogdensburg, John Dunbar (no. 45, type), June 12 and September 28, 1907; June 5, 1908.

Crataegus pelacris n. sp.

Glabrous with the exception of the hairs on the young leaves. Leaves ovate, acuminate, abruptly cuneate or rounded at the wide base, sharply often doubly serrate with straight or incurved glandular teeth, and divided usually above the middle into four or five pairs of small acuminate recurved lobes; tinged with red when they unfold, and at the end of May when the flowers open, thin, yellow-green, and covered above by short white hairs and glabrous below, and at maturity thick, glabrous, dark blue-green on the upper surface, pale blue-green on the lower surface, 4 to 5 cm long and 3 to 4.5 cm wide; petioles slender, sparingly glandular, 2 to 2.5 cm in length; leaves on vigorous shoots cuneate at the base, more coarsely serrate, more deeply lobed, and often 6 to 7 cm long and broad. Flowers 1.8 to 2 cm in diameter on slender pedicels, in small compact mostly five- or six-flowered corymbs, the much elongated lower peduncles from the axils of upper leaves; calyx-tube broadly obconic, the lobes separated by wide sinuses, gradually narrowed from the broad base, acuminate, entire or minutely glandular-dentate near the middle, reflexed after anthesis; stamens twenty; anthers large, bright rose color; styles five, surrounded at the base by a ring of white hairs. Fruit ripening in October on drooping pedicels, subglobose to obovoid, rounded at the ends, green and pruinose, becoming red when fully ripe, 1 to 1.2 cm in diameter; calyx prominent, with a short tube, a broad deep cavity wide in the bottom, and spreading lobes; flesh thin, hard and dry; nutlets five, thin and rounded at base, rounded and grooved on the back, 6 to 6.5 mm long and 4 mm wide, the broad conspicuous hypostyle extending to below the middle of the nutlet

A shrub 3 to 4 m high, with ascending stems and branches covered with dark gray bark near the ground, and stout, slightly zigzag branchlets dark orange-green and marked by pale lenticels when they first appear, dull chestnut-brown at the end of their first season and red-brown the following year, and armed with numerous stout straight or curved bright chestnut-brown shining spines 3 to 4.5 cm long.

Pastures near Olean, B. H. Slavin (no. 51, type), May 25 and September 19, 1908; pastures near Salamanca, B. H. Slavin (no. 18), June 6 and September 24, 1907.

Crataegus amoena Sargent

N. Y. State Mus. Bul. 122. 38, 86 (1908).

Niagara Falls and Coopers Plains.

Crataegus aristata Sargent

N. Y. State Mus. Bul. 150. 27 (1911).

Rossie.

Crataegus prominens Sargent

Ontario Nat. Sci. Bul. 4. 23 (1908).

Hemlock lake; also near Toronto, Canada.

Crataegus gracilis Sargent

N. Y. State Mus. Bul. 122. 37 (1908).

Niagara Falls and Coopers Plains.

Crataegus howeana Sargent

N. Y. State Mus. Bul. 105. 52 (1906).

Menands near Albany.

Crataegus latiflora n. sp.

Glabrous. Leaves broadly ovate, acute or acuminate, abruptly cuneate or rounded at the base, sharply doubly serrate with straight glandular teeth, and divided into four or five pairs of small acuminate lobes; more than half-grown when the flowers open in the first week of June and then thin, yellow-green, smooth and lustrous on the upper surface, pale on the lower surface, and at maturity 6 to 7 cm long and wide, with thin midribs and primary veins; petioles slender, narrowly wing-margined nearly to the middle, rose colored in the autumn, 1.5 to 2 cm in length; leaves on vigorous shoots sometimes rounded at the broad base, more coarsely serrate and more deeply lobed, often 8 cm long and wide, their petioles stout, glandular with persistent glands, 2 to 2.5 cm in length. Flowers 2.5 to 2.8 cm in diameter, on slender pedicels, in usually six- to eight-flowered corymbs, the lower peduncles from the axils of upper leaves; calyx-tube broadly obconic, the lobes separated by wide sinuses, broad, acuminate, coarsely glandular-serrate, reflexed after anthesis; stamens twenty; anthers pale pink; styles four or five. Fruit ripening in October on drooping pedicels, short-oblong, rounded at the ends, vermilion, marked by occasional large pale dots, 1 cm long and 8 to 9 mm in diameter; calyx prominent with a short tube, a broad deep cavity wide in the bottom, and spreading and appressed lobes mostly deciduous from the ripe fruit; nutlets four or five, acute at the ends, rather broader at the apex

than at the base, ridged on the back with a high, grooved ridge, 6 to 7 mm long and 4 to 4.5 mm wide, the broad hypostyle extending nearly to the middle of the nutlet.

An arborescent shrub 3 to 4 m high, with stems covered with brown scaly bark, and slender, slightly zigzag branchlets dark orange-green and marked by pale lenticels when they first appear, light chestnut-brown and lustrous at the end of their first season, and armed with occasional nearly straight chestnut-brown shining spines 4 to 5 cm long, persistent and compound on old stems and branches.

In heavy clay soil on the Miller farm in the town of Richmond, Livingston county, H. T. Brown (no. 64, type), June 4, 1906; October 1, 1909.

Crataegus pellecta Sargent

N. Y. State Mus. Bul. 122. 85 (1908).

Coopers Plains.

Crataegus ramosa Sargent

N. Y. State Mus. Bul. 122. 86 (1908).

Coopers Plains.

Crataegus scitula n. sp.

Glabrous. Leaves obovate, acuminate, gradually narrowed and cuneate at the entire base, finely doubly serrate with straight glandular teeth, and slightly divided above the middle into three or four pairs of narrow acuminate lobes; more than half-grown when the flowers open in the first week of June and then yellow-green and slightly tinged with red above and lustrous on the upper surface, pale on the lower surface, 5 to 6 cm long and 3 to 4 cm wide, with thin prominent midribs and primary veins; pedicels slender, wing-margined at the apex, glandular early in the season, 2 to 2.5 cm in length. Flowers on slender pedicels, in mostly twelve- to fifteen-flowered corymbs, the lower peduncles from the axils of upper leaves; calyx-tube broadly obconic, the lobes gradually narrowed from the base, slender, acuminate, glandular-serrate; stamens twenty; anthers pink; styles three to five. Fruit ripening in October, on drooping red pedicels, subglobose or sometimes rather longer than broad, crimson, marked by small pale dots, very pruinose, 9 to 11 mm in diameter; calyx prominent, with a short tube, a narrow deep cavity pointed in

the bottom, and spreading appressed lobes dark red on the upper side below the middle, flesh thin, dry and mealy; nutlets three to five, broad and rounded at the apex, narrowed at the base, ridged on the back with a broad high ridge, 6 to 7 mm long and 4 to 5 mm wide, the broad hypostyle extending to the middle of the nutlet.

A shrub 2 to 3 m high, with ascending stems and branches covered with ashy gray bark, and slender nearly straight branchlets dark orange-green and marked by pale lenticels when they first appear, becoming light chestnut-brown and lustrous at the end of their first season, and armed with numerous slender straight or slightly curved chestnut-brown shining spines 3 to 4 cm long.

Open pastures in heavy soil near Chapin, Ontario county, B. H. Slavin (no. 7, type), September 24, 1908 and May 29, 1909.

Crataegus conspecta Sargent

Ontario Nat. Sci. Bul. 4. 28 (1908).

Salamanca; also Chippewa and Niagara-on-the-Lake, Ontario.

Crataegus russata n. sp.

Glabrous. Leaves ovate to obovate, acuminate and long-pointed at the apex, abruptly or gradually narrowed and cuneate at the base, finely doubly serrate with straight glandular teeth, and slightly divided usually above the middle into short broad, acuminate lobes; nearly fully grown when the flowers open the end of May and then thin, smooth and lustrous above and paler below, and at maturity thick, dark yellow-green on the upper surface, pale on the lower surface, 4 to 4.5 cm long and 2.5 to 4.5 cm wide; petioles slender, narrowly wing-margined at the apex, glandular with occasional persistent glands, 1.5 to 2 cm in length; leaves on vigorous shoots broadly ovate, acuminate, rounded or truncate at the wide base, more coarsely serrate and more deeply lobed, and often 7 cm long and broad, their petioles stout, wing-margined nearly to the base, more or less glandular. Flowers 2 to 2.3 cm in diameter, on slender pedicels, in small compact 5–8-flowered corymbs, the lower peduncles from the axils of upper leaves; calyx-tube narrowly obconic, the lobes separated by wide sinuses, slender, elongated, acuminate, entire, minutely dentate near the middle, reflexed after anthesis; stamens twenty; anthers pale yellow or white; styles four or five,

surrounded at the base by a ring of pale tomentum. Fruit on slender drooping pedicels, ripening in October and persistent on the branches for several weeks, obovoid, rounded at the apex, gradually narrowed at the base, pale red, pruinose, 1.3 to 1.5 cm long and 1 cm in diameter; calyx prominent with a long tube, a wide deep cavity pointed in the bottom, and spreading lobes mostly deciduous from the ripe fruit; flesh hard and dry, tinged with red; nutlets four or five, rounded at the ends, rather broader at the apex than at the base, rounded and slightly grooved on the back, 6 mm long and 3.4 mm wide, the narrow hypostyle extending one-third the length of the nutlet.

A shrub 3 to 4 m high, with stout stems covered near the base with gray-brown scaly bark, ascending branches, and slender nearly straight zigzag branchlets dark orange-brown and marked by pale lenticels when they first appear, becoming bright chestnut-brown and lustrous at the end of their first season and dull gray-brown the following year, and armed with numerous slender straight dark chestnut-brown shining spines 3 to 5 cm long.

Hillsides, near Painted Post, Steuben county, common; G. D. Cornell (no. 132, type), October 1907; May 26, 1908.

Crataegus formosa Sargent

Proc. Rochester Acad. Sci. IV. 101 (1903).

Near Rochester, Coopers Plains, Murray, Niagara Falls, Buffalo and Salamanca.

Crataegus cognata Sargent

Rhodora V. 58 (1903); N. Y. State Mus. Bul. 122. 41 (1908).

Dykemans, Castile, Coopers Plains, Tuscarora, Hemlock lake, Niagara Falls, Buffalo, Chapin; also southern New England and southern Ontario.

Crataegus rubro-lutea Sargent

N. Y. State Mus. Bul. 122. 88 (1908).

Coopers Plains.

Crataegus casta Sargent

N. Y. State Mus. Bul. 105. 53 (1906).

Coopers Plains.

Crataegus leiophylla Sargent

Proc. Rochester Acad. Sci. IV. 99 (1903); N. Y. State Mus. Bul. 122. 41 (1908).

Ithaca, Coopers Plains, Belfast, Tuscarora, near Rochester, and Buffalo.

Crataegus macrocalyx Sargent

N. Y. State Mus. Bul. 122. 89 (1908).

Coopers Plains.

Crataegus clintoniana Sargent

N. Y. State Mus. Bul. 122. 39 (1908).

Buffalo.

Crataegus conjuncta Sargent

Rhodora V. 57 (1903); N. Y. State Mus. Bul. 105. 54 (1906).

Near Albany, common; also southern New England, eastern Pennsylvania, northern Illinois and Wisconsin.

Crataegus longipedunculata Sargent

Ontario Nat. Sci. Bul. 4. 26 (1908); Peck in N. Y. State Mus. Bul. 150. 28 (1911).

Near Canandaigua; also in southern Ontario.

Crataegus lennoniana Sargent

Proc. Rochester Acad. Sci. IV. 98 (1903).

Rochester, Murray, Adams Basin and Syracuse.

Crataegus bronxensis Sargent

N. Y. State Mus. Bul. 122. 115 (1908).

Bronx Park, New York City.

Crataegus uncta Sargent

N. Y. State Mus. Bul. 122. 91 (1908).

Coopers Plains.

Crataegus radiata Sargent

N. Y. State Mus. Bul. 122. 42 (1908).

Buffalo.

Crataegus placiva n. nom. Sargent

N. Y. State Mus. Bul. 122. 46 (1908) (not Sargent in Ontario Nat. Sci. Bul. (1908)).

Ithaca, Belfast and Buffalo.

Crataegus pulchra Sargent

N. Y. State Mus. Bul. 122. 42 (1908).

Ithaca, Chapin, Niagara Falls and Buffalo.

Crataegus aridula Sargent

N. Y. State Mus. Bul. 122. 43 (1908).

Niagara Falls.

Crataegus robbinsiana Sargent

Rhodora VII. 197 (1905); N. Y. State Mus. Bul. 105. 55 (1906).

Near Albany; also in western and southern Vermont and western New Hampshire.

Crataegus brevipes Peck

N. Y. State Mus. Bul. 139. 20 (1910).

Corning.

Crataegus plana Sargent

N. Y. State Mus. Bul. 122. 45 (1908).

Coopers Plains, Belfast, Castile, Almond, Hemlock lake and Buffalo.

Crataegus ovatifolia Sargent

N. Y. State Mus. Bul. 122. 92 (1908).

Coopers Plains.

Crataegus inusitula Sargent

N. Y. State Mus. Bul. 122. 55 (1908).

Chapin and Coopers Plains.

Crataegus exornata Sargent

Ontario Nat. Sci. Bul. 4. 31 (1908).

Salamanca; also southern Ontario.

MEDIOXIMAE

Crataegus dissona Sargent

Rhodora V. 60 (1903); N. Y. State Mus. Bul. 105. 54 (1906).

Moores Mills, Colemans Station, Dykemans, Albany, Coopers Plains; also western and southern New England, eastern Pennsylvania and southern Illinois.

Crataegus implicata Sargent

N. Y. State Mus. Bul. 122. 49 (1908).

Buffalo.

Crataegus deltoides Ashe

Jour. Elisha Mitchell Sci. Soc. XVII, pt. II, 19 (1901). Sargent, Proc. Acad. Nat. Sci. Phila. 603 (1905). Peck, N. Y. State Mus. Bul. 116. 21 (1907).

Moores Mills; also in eastern Pennsylvania.

Crataegus seclusa n. sp.

Glabrous with the exception of the hairs on the young leaves and calyx-lobes. Leaves broadly ovate, rounded or occasionally abruptly cuneate at the wide base, sharply doubly serrate with straight glandular teeth, and slightly divided into broad acuminate lobes; more than half-grown when the flowers open in the last week of May and then thin, yellow-green, smooth and slightly hairy above and glabrous and glaucescent below, and at maturity thin, dark yellow-green and glabrous on the upper surface, pale on the lower surface, 5 to 7 cm long and wide, with stout midribs, and prominent primary veins extending obliquely to the points of the lobes; petioles slender, narrowly wing-margined at the apex, slightly hairy on the upper side early in the season, soon becoming glabrous, occasionally glandular, 2 to 2.5 cm in length. Flowers 1.5 cm in diameter, on long slender pedicels, the lower peduncles from the axils of upper leaves; calyx-tube narrowly obconic, the lobes gradually narrowed from the base, short-acuminate, glandular-serrate, villose on the lower surface, reflexed after anthesis; stamens six to ten; anthers dark red; styles three or four, surrounded at the base by a ring of white tomentum. Fruit ripening at the end of September, on drooping red pedicels, subglobose, orange-red, marked by small pale dots, slightly pruinose, becoming lustrous, 1 cm in diameter; calyx little enlarged, with a broad, shallow cavity pointed in the bottom, and spreading closely appressed persistent lobes; flesh thin, dry and mealy; nutlets three or four, rounded at the ends, rather broader at the apex than at the base, ridged on the back with a broad grooved ridge, 1.6 to 1.7 cm long and 3 to 4 mm wide, the narrow hypostyle extending nearly to the base of the nutlet.

A shrub 5 to 6 m high, with stout stems covered with rough dark brown bark, ascending branches, and slender glabrous,

zigzag branchlets dark orange-green and marked by pale lenticels when they first appear, becoming light chestnut-brown and lustrous at the end of their first season and dull gray-brown the following year, and armed with stout slightly curved chestnut-brown shining spines 3.5 to 4 cm long.

On clay soil north of Hemlock lake in the town of Richmond, Livingston county, Henry T. Brown (no. 136, type), September 27, 1907; May 30, 1908.

Crataegus maineana Sargent

Proc. Rochester Acad. Sci. 4. 106 (1903); N. Y. State Mus. Bul. 122 46 (1908).

Hemlock lake, Rochester, Belfast and Buffalo.

Crataegus opulens Sargent

Proc. Rochester Acad. Sci. IV. 104 (1903).

Near Herkimer, Coopers Plains, Belfast, Hemlock lake, Rochester, Brighton, Buffalo; also in southeastern Michigan.

Crataegus perspicabilis n. sp.

Glabrous with the exception of the hairs on the young leaves and calyx-lobes. Leaves ovate, acuminate, rounded or abruptly cuneate at the broad base, coarsely doubly serrate with straight glandular teeth, and slightly divided into four or five pairs of short, broad, lateral lobes; more than half-grown when the flowers open from the 20th to the end of May, and then thin, yellow-green and sparingly furnished above with short white hairs and paler below, and at maturity thin but firm in texture, blue-green on the upper surface, pale blue-green on the lower surface, 5–7 cm long and 5–6 cm wide, with slender midribs and primary veins; petioles slender, slightly hairy on the upper side while young, soon becoming glabrous, glandular with occasional minute persistent glands, 3 to 3.5 cm in length; leaves on vigorous shoots ovate, acuminate, rounded, truncate or slightly obcordate at the wide base, thicker, more deeply lobed, coarsely serrate, often 10 to 11 cm long and broad, their petioles stout, glandular with prominent stipitate persistent glands. Flowers on long slender pedicels, in narrow mostly 4–10-flowered corymbs, the elongated lower peduncles from the axils of upper leaves; calyx-tube narrowly obconic, the lobes gradually narrowed from wide bases, long, slender, acuminate, ciliate or

obscurely toothed on the margins, slightly hairy on the inner surface below the middle, reflexed after anthesis; stamens 10; anthers light rose color; styles three. Fruit ripening in October, on slender pedicels, subglobose to short-oblong, truncate at the apex, rounded at the base, maroon, lustrous, marked by numerous pale dots, 1 to 1¼ cm in diameter; calyx little enlarged, with a wide shallow cavity tomentose in the bottom, and spreading persistent lobes; flesh thick, dry and mealy; nutlets three, rounded at the ends, rather broader at the apex than at the base, rounded and ridged on the back with a broad irregularly grooved ridge, 6 to 7 mm long and about 4 mm wide.

An arborescent shrub sometimes 4 m high, with stout stems covered with ashy gray bark, becoming dark and scaly near their base, ascending branches forming an open irregular head, and stout, zigzag branchlets dark orange-green and marked by pale lenticels when they first appear, chestnut or orange-brown at the end of their first season and dull red-brown the following year, and armed with numerous stout straight chestnut-brown spines 4.5 to 5 cm long.

Salamanca, B. H. Slavin (no. 43, type), October 6, 1907; May 26, 1908.

Crataegus macera Sargent

N. Y. State Mus. Bul. 122. 117 (1908).

Hemlock lake.

Crataegus diffusa Sargent

Proc. Rochester Acad. Sci. IV. 103 (1903).

Ithaca, Hemlock lake and Rochester.

Crataegus beckwithae Sargent

Proc. Rochester Acad. Sci. IV. 124 (1903).

Ithaca, Hemlock lake and Rochester.

Crataegus xanthophylla Sargent

N. Y. State Mus. Bul. 122. 48 (1908).

Buffalo.

Crataegus livingstoniana Sargent

N. Y. State Mus. Bul. 122. 116 (1908).

Hemlock lake.

Crataegus strigosa Sargent

N. Y. State Mus. Bul. 122. 51 (1908).

Buffalo and near Herkimer.

Crataegus compta Sargent

Proc. Rochester Acad. Sci. IV. 102 (1903).

Near Utica, Rochester and Buffalo.

Crataegus tortuosa Sargent

N. Y. State Mus. Bul. 122. 47 (1908).

Utica, Ithaca and Buffalo.

Crataegus promissa Sargent

N. Y. State Mus. Bul. 122. 50 (1908).

Filmore, Hemlock lake, Niagara Falls; also in southern Ontario.

Crataegus congestiflora Sargent

N. Y. State Mus. Bul. 122. 44 (1908).

Near Herkimer, Castile, Belfast, Olean, Palmyra, Buffalo and Salamanca.

Crataegus numerosa Sargent

N. Y. State Mus. Bul. 122. 90 (1908).

Coopers Plains.

Crataegus foliata Sargent

N. Y. State Mus. Bul. 122. 53 (1908).

Niagara Falls.

Crataegus colorata Sargent

Proc. Rochester Acad. Sci. IV. 123 (1903); N. Y. State Mus. Bul. 122. 60 (1908).

Dykemans, near Herkimer, Ithaca, Chapinville, Rochester, Hemlock lake, Belfast, Coopers Plains, Murray, Buffalo, Salamanca; also in southern Ontario and Michigan.

Crataegus cruda Sargent

N. Y. State Mus. Bul. 122. 54 (1908).

Hemlock lake, Niagara Falls and Salamanca.

Crataegus acerba Sargent

N. Y. State Mus. Bul. 122. 93 (1908).

Coopers Plains and Olean.

Crataegus dissociabilis Sargent

N. Y. State Mus. Bul. 122. 95 (1908).

Coopers Plains.

Crataegus barryana Sargent

N. Y. State Mus. Bul. 122. 52, 93 (1908).

Corning, Rochester, Hemlock lake and Coopers Plains.

TENUIFOLIAE

Crataegus ignea Sargent

N. Y. State Mus. Bul. 122. 96 (1908).

Coopers Plains and Little Falls.

Crataegus hadleyana n. sp.

Leaves broadly ovate, acuminate, rounded or cuneate at the base, finely often doubly serrate with straight glandular teeth, and slightly divided into four or five pairs of short acuminate lateral lobes; nearly fully grown when the flowers open at the end of May and then thin, light yellow-green and roughened above by short white hairs and paler and glabrous below, and at maturity firm in texture, glabrous, dark yellow-green and lustrous on the upper surface, pale on the lower surface, 6 to 8 cm long and 5 to 6.5 cm wide, with stout midribs, and slender primary veins arching obliquely to the points of the lobes; petioles stout, wing-margined at the apex, sparingly villose on the upper side while young, becoming glabrous, glandular with occasional minute deciduous glands, 1.5 to 2.5 cm in length. Flowers 1.5 to 1.7 cm in diameter, on long slender slightly villose pedicels, in wide mostly 15–18-flowered corymbs, the much elongated slender nearly glabrous lower peduncles from the axils of upper leaves; calyx-tube narrowly obconic, slightly villose, the lobes long, slender, acuminate, conspicuously glandular-serrate, glabrous on the outer surface, sparingly villose on the inner surface, reflexed after anthesis; stamens six to ten, usually six; anthers rose color; styles two to five, surrounded at the base by a broad ring of white hairs. Fruit ripening early in October, on glabrous pedicels, in wide, drooping clusters, short-oblong, rounded at the ends, scarlet, lustrous, marked by large pale dots, 1 to 1.2 cm long and 9 to 10 cm in diameter; calyx little enlarged, with a deep, narrow cavity pointed in the bottom, and spreading lobes dark red on the upper side below the middle, their tips mostly deciduous from the ripe fruit; flesh thin, tinged with red, soft and succulent; nutlets usually two or three, rounded and broadest at the apex, gradually narrowed and rounded at the base, ridged on the back with a broad grooved ridge, 7 to 8

mm long and 4 to 5 mm wide, the narrow hypostyle extending nearly to the base of the nutlet.

A shrub with stout, slightly zigzag glabrous branchlets light orange-green and marked by numerous orange colored lenticels when they first appear, becoming light chestnut-brown and lustrous at the end of their first season and dull red-brown the following year, and armed with stout curved chestnut-brown shining spines 3 to 3.5 cm long.

Rocky hilltops north of the Mohawk river, Beaver brook valley, three miles east of Herkimer, J. V. Haberer (no. 2444, type), October 1907, May 28 and October 1, 1912.

This handsome and distinct plant is named in memory of James Hadley M.D. (1785–1869), professor of chemistry and natural sciences in the Fairfield Medical College of Physicians and Surgeons at Fairfield, Herkimer county, and later professor of chemistry and natural sciences in Hamilton College, an active and successful student of the plants of central New York and at Fairfield instructor in botany of Asa Gray.

Crataegus suavis Sargent

N. Y. State Mus. Bul. 122. 59 (1908).

Clayton, Ithaca, Frankfort, East Aurora, Buffalo, Niagara Falls, Hemlock lake, Coopers Plains, Salamanca, Cattaraugus creek.

Crataegus boothiana Sargent

N. Y. State Mus. Bul. 122. 58 (1908).

Rochester, Monroe, Fillmore, Tuscarora, Almond.

Crataegus slavinii Sargent

N. Y. State Mus. Bul. 122. 57 (1908).

Brighton, Hemlock lake, Almond and Salamanca.

Crataegus ascendens Sargent

Rhodora V. 141 (1903); N. Y. State Mus. Bul. 105. 57 (1906).

Thompsons lake near Albany; also in western Vermont.

Crataegus acuminata Sargent

N. Y. State Mus. Bul. 105. 56 (1906).

Near Albany and Herkimer.

Crataegus tenella Ashe

Ann. Carnegie Mus. I, pt III. 338 (1902). Sargent, Bot. Gazette XXXV. 108. Peck, N. Y. State Mus. Bul. 116. 23 (1907).

Colemans Station, Moores Mills, Dykemans; also in eastern Pennsylvania and Delaware.

Crataegus spatifolia Sargent

N. Y. State Mus. Bul. 122. 98 (1908).

Coopers Plains.

Crataegus nescia Sargent

N. Y. State Mus. Bul. 122. 100 (1908).

Coopers Plains.

Crataegus rubrocarnea Sargent

N. Y. State Mus. Bul. 105. 55 (1906).

Albany.

Crataegus glaucophylla Sargent

Rhodora V. 140 (1903); Proc. Rochester Acad. Sci. IV. 12; N. Y. State Mus. Bul. 122. 102 (1908).

Westport, near Herkimer, Chapin, Rochester, Hemlock lake, Portage, Castile, Belfast, East Aurora, Coopers Plains; also western Pennsylvania, southern Ontario and Michigan.

Crataegus demissa Sargent

Rhodora V. 139 (1903); N. Y. State Mus. Bul. 105. 55 (1906).

Near Albany, Gansevoort, Ithaca, Chapin and Tuscarora.

Crataegus delucida Sargent

Rhodora V. 139 (1903); N. Y. State Mus. Bul. 105. 55 (1906).

Near Albany; also in western Vermont.

Crataegus matura Sargent

Rhodora III. 24 (in part) (1901); Rhodora v. III (1903); Proc. Rochester Acad. Sci. IV. 126.

Moores Mills, Dykemans, Lewis Point, Oneida lake, Chapin, Hemlock lake, Belfast, Coopers Plains, Olean; also in western New England and southern Ontario.

Crataegus streeterae Sargent

Proc. Rochester Acad. Sci. IV. 119 (1903); N. Y. State Mus. Bul. 122. 62 (1908).

Ithaca, Frankfort, near Utica, Chapin, Rochester, Belfast, Coopers Plains, Buffalo, Niagara Falls; also in southern Michigan.

Crataegus rubicunda Sargent

Proc. Rochester Acad. Sci. IV. 121 (1903); N. Y. State Mus. Bul. 122. 60 (1908).

Chapin, Rochester, Belfast, Hermitage; also in southern Ontario.

Crataegus recta Sargent

N. Y. State Mus. Bul. 122. 97 (1908).

Coopers Plains.

Crataegus insignata Sargent

N. Y. State Mus. Bul. 122. 101 (1908).

Coopers Plains.

Crataegus fucata Sargent

N. Y. State Mus. Bul. 122. 99 (1908).

Coopers Plains.

Crataegus pentandra Sargent

Rhodora III. 25 (1901); Silva N. Am. XIII. 129, t. 681; N. Y. State Mus. Bul. 105. 35 (1906).

Moores Mills, Pawling and near Albany, west of Whetstone; also in western New England.

Crataegus bella Sargent

N. Y. State Mus. Bul. 122. 61 (1908).

Ithaca, Chapin, Hemlock lake, Coopers Plains, Belfast, Buffalo, Buffalo, Salamanca, Cattaraugus creek; also in southern Ontario.

Crataegus ornata Sargent

Proc. Rochester Acad. Sci. IV. 120 (1903); N. Y. State Mus. Bul. 122. 60 (1908).

Lenox, Madison City, near Utica, Rochester, Coopers Plains, Buffalo and LaSalle.

Crataegus genialis Sargent

Rhodora V. 148 (1908); N. Y. State Mus. Bul. 105. 55 (1906).

Near Albany, Little Falls, Belfast, Coopers Plains and Buffalo; also in southern Ontario.

Crataegus leptopoda Sargent

N. Y. State Mus. Bul. 122. 118 (1908).

Hemlock lake, Canadice lake and Almond.

Crataegus paineana n. sp.

Glabrous with the exception of the hairs on the young leaves. Leaves ovate, acuminate, rounded or cuneate at the base, finely serrate with straight slender teeth and divided usually only above the middle into short broad acute lobes; more than half grown when the flowers open about the first of June and then yellow-green and slightly roughened above by short white hairs, and at maturity thin, dull yellow-green on the upper surface, paler on the lower surface, 4 to 5 cm long and 3 to 3.5 cm. wide, with slender midribs and primary veins; petioles slender, slightly wing-margined at the apex, 2 to 3 cm in length; leaves on vigorous shoots ovate, abruptly acuminate, broad and rounded or cuneate at the base, coarsely serrate, often deeply lobed, 1.7 to 1.8 cm long and 6 to 7 cm wide, their petioles stout, wing-margined to the middle, rose-colored and often glandular in the autumn. Flowers on long slender pedicels, in many-flowered corymbs, the much elongated lower peduncles from the axils of upper leaves; calyx-tube narrowly obconic, tne lobes gradually narrowed from the base, long and slender, entire, reflexed after anthesis; stamens five to nine; anthers rose color; styles two to four. Fruit ripening at the end of September, on elongated pedicels, in many-fruited drooping clusters, long-obovoid, rounded at the apex, gradually narrowed to the base, scarlet, lustrous, marked by small pale dots, 2 to 5 cm long and 1 cm in diameter; calyx little enlarged, with a very narrow and deep cavity, the lobes appressed and mostly deciduous from the ripe fruit; flesh thick, orange-colored, sweet and of good flavor; nutlets two to four, usually three, narrowed and rounded at the ends, rather broader at the apex than at the base, ridged on the back with a narrow grooved ridge, 7 to 8 mm long and about 4 mm wide, the narrow hypostyle extending to below the middle of the nutlet.

A shrub 3 to 4 m high, with numerous erect stems and branches forming an open round-topped head, and stout, slightly zigzag branchlets tinged with red when they first appear, becoming dull reddish or orange-brown at the end of their first season, and armed with numerous stout or slender incurved chestnut-brown spines 2 to 4 cm long.

Rocky upland pastures, Beaver brook valley north of the Mohawk river and two or three miles east of Herkimer, very common, J. V. Haberer (no. 2518, type), June 10 (the petals fallen) and September 30, 1907; Haberer, Dunbar and Sargent, September 26, 1912.

This species, which, in autumn when it is covered with its innumerable drooping clusters of brilliant fruit, is one of the most beautiful of all the Tenuifoliae, is named in memory of John A. Paine, jr (1840–1912), author of "A Catalogue of Plants of Oneida County and Vicinity."

Crataegus gracilipes Sargent

N. Y. State Mus. Bul. 122. 119 (1908).

Near Herkimer and Hemlock lake.

Crataegus habereri Sargent

N. Y. State Mus. Bul. 116. 21 (1907).

Near Utica.

Crataegus parviflora Sargent

Proc. Rochester Acad. Sci. IV. 117 (1903).

Ithaca, Chapin, Penfield, Rochester, Hemlock lake, Cattaraugus creek.

Crataegus tenuiloba Sargent

Proc. Rochester Acad. Sci. IV. 122 (1903).

Lenox, Rochester, Penfield, Hemlock lake and Buffalo.

Crataegus claytoniana Sargent

N. Y. State Mus. Bul. 122. 120 (1908).

Clayton.

Crataegus stolonifera Sargent

Bot. Gazette XXXV. 109 (1903).

Tuscarora; also in Delaware, eastern and western Pennsylvania and southern Michigan.

Crataegus edsonii Sargent

Rhodora VII. 205 (1905); N. Y. State Mus. Bul. 105. 57 (1906).

Lansingburg; also in western New England.

Crataegus conferta Sargent

N. Y. State Mus. Bul. 122. 62 (1908).

Ithaca, near Rochester, Buffalo and Salamanca.

Crataegus benigna Sargent

Proc. Rochester Acad. Sci. IV. 127 (1903).

Rochester, Silver Springs and Belfast.

Crataegus mellita Sargent

N. Y. State Mus. Bul. 105. 58 (1906).

Sand Lake, near Albany.

Crataegus luminosa Sargent

N. Y. State Mus. Bul. 122. 63 (1908).

Buffalo.

COCCINEAE

Crataegus holmesiana Ashe

Jour. Elisha Mitchell Sci. Soc. XVI, pt II. 78 (1900). Sargent Silva N. Am. XIII. 119, t. 676; Proc. Rochester Acad. Sci. IV. 114 (1903).

Phoenicia, Albany, Ogdensburg, Little Falls, near Utica, Oriskany, Elmira, Ithaca, Syracuse, Rochester, Hemlock lake, Belfast, Castile, Buffalo; also in Quebec and Ontario, New England and Pennsylvania.

Crataegus acclivis Sargent

Proc. Rochester Acad. Sci. IV. 115 (1903); N. Y. State Mus.. Bul. 122. 71 (1908).

Albany, near Utica, Ithaca, Chapin, Rochester, Hemlock lake, Belfast, Niagara Falls and Buffalo.

Crataegus uticaensis n. sp.

Leaves ovate, acute or acuminate, abruptly cuneate or gradually narrowed and rounded or broad and rounded at the base, coarsely serrate with straight glandular teeth, and divided above the middle into four or five pairs of short acuminate lobes; more than half grown when the flowers open about the 20th of May and then ellow-green, roughened above by short white hairs and paler and glabrous below, and at maturity yellow-green, smooth and glabrous on the upper surface, 6 to 7 cm long and 5 to 5.5 cm wide, with thin midribs and primary veins; petioles slender, sparingly villose when they first appear, soon becoming glabrous, glandular with occasional small deciduous glands, 1.5 to 2.5 cm in length; stipules linear, acuminate, conspicuously glandular, caducous; leaves on vigorous shoots cuneate, rounded or slightly cordate at the wide base, more coarsely serrate and more deeply lobed, often 8 cm long and wide. Flowers 2 to 2.2 cm in diameter, on slender sparingly villose pedicels, in compact slightly hairy mostly 8–14-flowered corymbs, the lower peduncles from the axils of upper leaves; calyx-tube narrowly obconic, hairy with occasional white hairs or nearly glabrous, the lobes separated by broad sinuses, short, broad, entire or occasionally

glandular-dentate near the middle, glabrous, reflexed after anthesis; stamens five or six; anthers rose color; styles three or four. Fruit ripening and falling in September, on slender drooping pedicels, short-oblong, rounded at the ends, scarlet, marked by large pale dots, about 1.5 cm long and 1.2 to 1.3 cm in diameter; calyx little enlarged with a wide deep cavity pointed in the bottom, and spreading lobes dark red on the upper side below the middle; flesh thick, orange color; nutlets three or four, narrowed and rounded at the ends, ridged on the back with a low rounded ridge, 7 to 8 mm long and 4 to 5 mm wide, the broad conspicuous hypostyle extending to below the middle of the nutlet.

An arborescent shrub 5 to 7 m high, growing singly or in clumps, with ascending stems and branches covered with ashy gray bark and forming a pyramidal head, stout glabrous branchlets tinged with red when they first appear, becoming light orange-brown, lustrous and marked by pale lenticels during their first season and ashy gray the following year, and armed with slender nearly straight dark brown shining spines 4.5 to 5 cm long.

Hills south of Utica, common; J. V. Haberer (no. 2441, type, 2441A, 2441B), May 24 and September 19, 1912. Rocky banks north of the Mohawk river at Little Falls, J. V. Haberer (no. 2439), May 6, 1907; Haberer and Dunbar, September 27, 1912.

Crataegus pringlei Sargent

Rhodora III. 21 (1901); Silva N. Am. XIII. 111, t. 672; Proc. Rochester Acad. Sci. IV. 112 (1903).

Crown Point, Colemans Station, Fort Ann, Oriskany, near Little Falls, near Herkimer, Marcy, Chapin, Rochester, Hemlock lake; also in western New England, southern Ontario, Michigan and Illinois.

Crataegus lobulata Sargent

Rhodora III. 22 (1901); Silva N. Am. XIII. 117, t. 675; N. Y. State Mus. Bul. 105. 63 (1906).

Sand Lake, near Albany, Crown Point; also in western and southern New England.

Crataegus pedicellata Sargent

Bot. Gazette XXXI. 226 (1901); Silva N. Am. XIII. 121, t. 677; N. Y. State Mus. Bul. 122. 69 (1908).

New Hartford, Little Falls, Chapin, Syracuse, Rochester, Hemlock lake, East Aurora, Buffalo, Salamanca; also in southern Ontario and western Pennsylvania.

Crataegus gloriosa Sargent

N. Y State Mus. Bul. 122. 70 (1908).

Rochester.

Crataegus letchworthiana Sargent

N. Y. State Mus. Bul. 122. 69 (1908).

Near Portage.

Crataegus vivida Sargent

Ontario Nat. Sci. Bul. 4. 47 (1908).

Ithaca, Chapin, Cattaraugus creek; also in southern Ontario.

Crataegus tardipes Sargent

Ontario Nat. Sci. Bul. 4. 51 (1908).

Utica, Salamanca; also in southern Ontario.

Crataegus polita Sargent

Rhodora V. 112 (1903); N. Y. State Mus. Bul. 105. 63 (1906).

Sand Lake, near Albany, Little Falls, near Herkimer and Utica.

Crataegus sejuncta Sargent

N. Y. State Mus. Bul. 105. 62 (1906).

Albany, Buffalo; also in western New England.

Crataegus dayana Sargent

N. Y. State Mus. Bul. 122. 66 (1908).

Hemlock lake, Buffalo and Cattaraugus creek.

Crataegus gilbertiana n. sp.

Leaves ovate, acute, cuneate or rounded at the broad base, sharply often doubly serrate with straight glandular teeth, and slightly divided into four or five pairs of short acuminate lateral lobes; about one-third grown when the flowers open the middle of June and then thin, yellow-green, roughened above by short white hairs and slightly hairy below along the midribs and veins, and at maturity thin, dark blue-green and glabrous on the upper surface, paler on the lower surface, still slightly hairy on the thin midribs and primary veins, 7 to 8 cm long and 5.5 to 6.5 cm wide; petioles slender, slightly wing-margined at the apex, glabrous, 2.5 to 3 cm in length; leaves on vigorous shoots acuminate, abruptly cuneate at the base, more coarsely

serrate, often deeply lobed, 10 to 12 cm long and 9 to 10 cm wide, with stout glandular winged petioles. Flowers about 2 cm in diameter, on slender slightly villose pedicels, in erect sparingly hairy mostly 10–12-flowered corymbs, the elongated lower peduncles from the axils of upper leaves; calyx-tube narrowly obconic, thickly covered with long white hairs, the lobes separated by wide sinuses, slender, acuminate, entire, glabrous on the upper surface, slightly villose on the lower surface, reflexed after anthesis; stamens twenty; anthers red; styles three or five. Fruit ripening in October, on long drooping nearly glabrous pedicels, obovoid, rounded at the apex, gradually and abruptly narrowed at the base, crimson, lustrous, marked by small pale dots, 1.5 to 1.8 cm long and 1.3 to 1.5 cm in diameter; calyx with a short neck, a broad deep cavity pointed in the bottom, and spreading mostly deciduous lobes; flesh very thin, orange-colored, dry and mealy; nutlets gradually narrowed and rounded at the ends, slightly ridged on the back, 8 to 9 mm wide, the narrow hypostyle extending to just below the middle of the nutlet.

An arborescent shrub 6 to 7 m high, with ascending stems sometimes 3 dm in diameter at the base, and covered with ashy gray scaly bark, and stout nearly straight glabrous branchlets dark orange-green and marked by pale lenticels when they first appear, becoming bright chestnut-brown and very lustrous at the end of their first season and pale gray the following year, and armed with stout nearly straight chestnut-brown spines 3 to 4 cm long.

Pastures and meadows on the borders of Mud lake in Warren, Herkimer county, common; J. V. Haberer (no. 2414), June 16 and October 9, 1907; Haberer, Dunbar and Sargent, September 28, 1912.

The blue color of the leaves of this species is unusual in plants of the Coccineae group. It is named in memory of Benjamin Davis Gilbert (1835–1907), a native of Clayville, New York, and for many years a resident of Utica where he was a successful bookseller and the agricultural editor of the Utica Morning Herald, secretary of the New York Dairymen's Association, and secretary and treasurer of the Central New York Farmers Club. Mr Gilbert, who early became interested in ferns, was the author of many papers on these plants and an industrious and careful student of the flora of central New York.

Crataegus steubenensis Sargent

N. Y. State Mus. Bul. 122. 103 (1908).

Coopers Plains.

Crataegus irrasa Sargent

Rhodora V. 116 (1903).

Keene, Essex co.; also in the Province of Quebec.

Crataegus perrara n. sp.

Leaves ovate to broadly oval, acute at the apex, rounded or sharply cuneate at the broad base, finely often doubly serrate with straight glandular teeth, and divided above the middle into four or five pairs of short broad acuminate lobes; nearly fully grown when the flowers open at the end of May and then thin, yellow-green, roughened above by short white hairs and glabrous below, and at maturity thin, yellow-green, scabrate on the upper surface, pale on the lower surface, more or less contorted, 4.5 to 5.5 cm long and 3.5 to 4.5 cm wide, with thin midribs and primary veins; petioles slender, glabrous, 2 to 3 cm in length; leaves on vigorous shoots rounded, truncate or abruptly cuneate at the broad base, coarsely serrate, deeply divided into broad lateral lobes and often 8 to 9 cm long and 7 to 8 cm wide. Flowers 2 cm in diameter, on stout slightly hairy pedicels, in compact many-flowered corymbs, the lower peduncles from the axils of upper leaves; calyx-tube narrowly obconic, sparingly villose with long white hairs, the lobes slender, acuminate, coarsely glandular-serrate, slightly hairy on the outer surface, glabrous on the inner surface, reflexed after anthesis; stamens five to eight; anthers white; styles three to five. Fruit ripening the middle of September on drooping red pedicels, short-oblong to slightly obovoid, rounded at the ends, crimson, lustrous, marked by small pale dots, 1.5 to 1.8 cm long and 1 to 1.2 cm in diameter; calyx little enlarged with a deep narrow cavity, and erect often incurved lobes; flesh thin, yellow, dry and mealy; nutlets near the apex of the fruit, three to five, broadest and rounded at the apex, gradually narrowed to the base, slightly and irregularly ridged on the back, 6 to 7 mm long and 4 to 5 mm wide.

A shrub 5 to 6 m high with ascending branches, dark brown scaly bark, and stout zigzag branchlets dark orange-green and

slightly villose when they first appear, becoming light chestnut-brown, lustrous and marked by small pale lenticels at the end of their first season and light red-brown the following year, and unarmed or armed with occasional chestnut-brown spines 5 to 6 cm long.

Meadows in rich moist soil, near Chapinville, Ontario county, B. H. Slavin (no. 35, type), May 29 and September 17, 1909; Honeoye lake region, Ontario county, Henry T. Brown (no. 76). June 7 and September 19, 1907.

Crataegus limosa Sargent

N. Y. State Mus. Bul. 122. 67 (1908).

Near Rochester.

Crataegus flabellata (Spach) Sargent

Rhodora III. 75 (1901); Rhodora V. 114 (1903).

Mespilus flabellata Bosc, ex Spach Hist. Vég. II. 63 (1834).

Crown Point and Rossie; also in western Vermont, New Hampshire, Province of Quebec, Massachusetts and Connecticut.

MOLLES

Crataegus champlainensis Sargent

Rhodora III. 20 (1901); Silva N. Am. XIII, 105, t. 667; N. Y. State Mus. Bul. 105. 59 (1906).

Crown Point, Port Henry, near Albany, Greenbush, Ogdensburg, Chapin, Hemlock lake; also in western New England, Quebec and southern Ontario.

Crataegus contortifolia Sargent

N. Y. State Mus. Bul. 105. 59 (1906).

North Albany and North Greenbush.

Crataegus ellwangeriana Sargent

Bot. Gazette XXXIII. 1184 (1902); Silva N. Am. XIII, 109, t. 671; Proc. Rochester Acad. Sci. IV. 112 (1903).

Ithaca, Ogdensburg, Chapinville, Canandaigua, Rochester, Hemlock lake, Portage, Salamanca; also in southern Ontario, Michigan and western Pennsylvania.

Crataegus robesonana Sargent

Rhodora, v. 110 (April 1903)

Crataegus spissiflora Sargent Proc. Rochester Acad. Sci. IV. 112 (June 1903); N. Y. State Mus. Bul. 105. 61 (1906).

Near Albany, Little Falls, Lenox, Ithaca, Rochester, Hemlock lake; also in southern Ontario and western Massachusetts.

Crataegus exclusa Sargent

Rhodora V. 108 (1903); N. Y State Mus. Bul. 105. 60 (1906).

Near Albany, Greenbush, Chapinville; also in western Vermont.

Crataegus urbica nov. nom. Sargent

Crataegus oblongifolia Sargent, N. Y. State Mus. Bul. 105. 60 (not K. Kock) (1906).

Near Albany.

Crataegus anomala Sargent

Rhodora III. 74 (1901).

Crown Point and Fort Ann; also in western Vermont and the province of Quebec.

Crataegus huntiana n. sp.

Leaves ovate, acute, rounded or abruptly cuneate at the broad base, coarsely often doubly serrate with straight glandular teeth, and slightly divided into short acuminate lateral lobes; about one-third grown when the flowers open the middle of June and then thin, light yellow-green and covered by short white hairs longest and most abundant on the lower side of the midribs and veins, and at maturity thin, blue-green, glabrous and lustrous on the upper surface, paler on the lower surface and slightly hairy on the prominent midribs and four or five pairs of primary veins arching obliquely to the points of the lobes, 7 to 8 cm long, 6 to 7 cm wide, and on vigorous shoots sometimes 10 to 12 cm long and 8 to 9 cm wide; petioles stout, densely villose early in the season, tinged with red and glabrous in the autumn, 2 to 3 cm in length. Flowers 1.8 to 2 cm in diameter, on slender villose pedicels, in small densely villose mostly 12-flowered corymbs, the long lower peduncles from the axils of upper leaves; calyx-tube narrowly obconic, densely villose, the lobes narrow, acuminate, conspicuously glandular-serrate, slightly villose; stamens seven to ten; anthers rose color; styles four or five. Fruit ripening early in October, on stout drooping slightly

hairy pedicels, broadly obovoid, occasionally slightly decurrent on the pedicel, scarlet, very lustrous, marked by few large white dots, slightly pubescent at the ends, 1.8 to 2 cm long and 1.6 to 1.8 cm in diameter, villose at the base of the little enlarged calyx with a deep narrow cavity pointed in the bottom, and erect and incurved often deciduous lobes densely villose on the inner surface; flesh yellow, dry and mealy, of good flavor; nutlets four or five, placed above the middle of the fruit, broad and rounded at the apex, gradually narrowed to the base, rounded and slightly grooved on the back, 9 to 10 mm long and 5 to 6 mm wide, the conspicuous hypostyle extending nearly to the base of the nutlet.

A round-topped shrub 3 to 4 m high, with numerous stout erect stems and branches and slender slightly zigzag branchlets, light orange-green and thickly covered when they first appear with long white hairs, glabrous, light orange-brown, lustrous and marked by dark lenticels in their first autumn and light brown the following year, and armed with straight or slightly curved dark red-brown shining spines 2.5 to 5 cm long.

Roadsides and rocky pastures between Jordanville and Mud lake, on the headwaters of the Susquehanna river, Herkimer county; J. V. Haberer (no. 2450, type), June 16 and October 19, 1907; Haberer, Dunbar and Sargent, September 28, 1912.

This handsome shrub is named in memory of Edwin Hunt (1837–80), for many years professor of natural sciences in the Utica Free Academy, a successful teacher of botany and a careful and industrious student of the flora of central New York.

Crataegus radians Sargent

N. Y. State Mus. Bul. 122. 64 (1908).

Rochester.

Crataegus fulleriana Sargent

Proc. Rochester Acad. Sci. IV. 111 (1903).

Rochester.

DILATATAE

Crataegus dilatata Sargent

Bot. Gazette XXXI. 9 (1901); Silva N. Am. XIII, 113, t. 672; N. Y. State Mus. Bul. 105. 63 (1906).

Thompsons lake near Albany, Gansevoort; also New England and Province of Quebec.

Crataegus hudsonica Sargent

Man. 457, f. 373 (1905); N. Y. State Mus. Bul. 105. 63 (1906).

Near Albany and Greenbush.

Crataegus durobrivensis Sargent

Trees and Shrubs I. 3, t. 2 (1902); Rochester Acad. Sci. IV. 114 (1903); N. Y. State Mus. Bul. 105. 64 (1906).

Near Albany, Ithaca, Canandaigua, Rochester, Hemlock lake, Portage and Niagara Falls.

INTRICATAE

Crataegus intricata Lange

Bot. Tidskr. XIX. 246 (1894). Sargent, N. Y. State Mus. Bul. 105. 67 (1906).

Moores Mills, near Albany, Lansingburg, Coopers Plains; also in New England and southern Pennsylvania.

Crataegus cornellii Sargent

N. Y. State Mus. Bul. 122. 105 (1908).

Coopers Plains.

Crataegus verecunda Sargent

Proc. Rochester Acad. Sci. IV. 109 (1903); N. Y. State Mus. Bul. 105. 68 (1906).

Lansingburg, Corning, Ithaca, Rochester, Hemlock lake and Coopers Plains.

Crataegus modesta Sargent

Rhodora III. 28 (1901); N. Y. State Mus. Bul. 105. 68 (1906).

Moores Mills, near Albany, Coopers Plains; also in New England and eastern Pennsylvania.

Crataegus foetida Ashe

Ann. Carnegie Mus. I. pt III. 389 (1902). Sargent, N. Y. State Mus. Bul. 105. 68 (1906).

Crataegus baxteri Sargent, Proc. Rochester Acad. Sci. IV. 107 (1903).

Lansingburg, Albany, Ithaca, Chapinville, Rochester, Hemlock lake, Castile, Coopers Plains; also in western Massachusetts, eastern Pennsylvania and southern Ontario.

Crataegus bissellii Sargent

Rhodora V. 65 (1903).

Staatsburg; also in southern Connecticut.

Crataegus peckii Sargent

Rhodora V. 63 (1903); N. Y. State Mus. Bul. 105. 68 (1906).

Lansingburg.

ROTUNDIFOLIAE

Crataegus rotundifolia (Ehrhart) Moench

Baum. Weiss. 29, t. 1 (1785).

Crataegus coccinea var. rotundifolia Sargent, Bot. Gazette XXXI. 14 (1900); N. Y. State Mus. Bul. 105. 64 (1906).

Moores Mills, Albany, Crown Point, Lake Placid, Ogdensburg; also New England, Province of Quebec and Pennsylvania.

Var. pubera Sargent, Rhodora XI. 183 (1909).

Crataegus coccinea Sargent, Silva N. Am. XIII. 133, t. 683 (not Linneus) (1902); N. Y. State Mus. Bul. 105. 64 (1906).

Pawling, Albany, North Elba, Chateaugay, Lake Placid, Buffalo; also New England, eastern Canada, Quebec, Ontario and Michigan.

Crataegus dodgei Ashe

Jour. Elisha Mitchell Sci. Soc. XIX. 26 (1901). Sargent, N. Y. State Mus. Bul. 105. 64 (1906).

Near Albany, Elmira, Buffalo, Belfast, Tuscarora, Coopers Plains; also in New England, eastern Pennsylvania and in southern Ontario and Michigan.

Crataegus caesariata Sargent

N. Y. State Mus. Bul. 105. 604 (1906).

Near Albany.

Crataegus divergens Sargent

N. Y. State Mus. Bul. 105. 66 (1906).

North Greenbush.

Crataegus illuminata Sargent

N. Y. State Mus. Bul. 105. 65 (1906).

North Greenbush.

Crataegus maribella n. sp.

Glabrous with the exception of the hairs on the young leaves and calyx-lobes. Leaves elliptical to obovate or ovate, acute or acuminate, cuneate at the entire base, finely doubly serrate above with straight glandular teeth, and slightly divided above the middle into narrow acuminate lobes; about half grown when the flowers open the end of May and then thin, light yellow-green and roughened above by short white hairs and glaucescent and glabrous below, and at maturity thick, yellow-green, smooth and lustrous on the upper surface, pale on the lower surface, 6 to 8 cm long and 4 to 4.5 cm wide, with stout midribs and thin primary veins extending obliquely to the points of the lobes; petioles stout, red in the autumn, 2 to 2.5 cm in length; leaves on vigorous shoots ovate, rounded at the wide base, 7 to 8 cm long and 6 to 7 cm wide, with stout, winged glandular petioles. Flowers 2 cm in diameter, on long slender pedicels, in wide lax mostly 10–14-flowered corymbs, the much elongated lower peduncles from the axils of upper leaves; calyx-tube narrowly obconic, the lobes separated by wide sinuses, gradually narrowed from the base, long-acuminate, coarsely glandular-serrate, slightly villose on the inner surface, reflexed after anthesis; stamens twenty; anthers white; styles two to four. Fruit ripening the end of September on slender drooping pedicels, short-oblong, rounded at the ends, crimson, lustrous, marked by large pale dots, 1 to 1.2 cm long and 9 to 10 mm in diameter; calyx little enlarged with a deep narrow cavity pointed in the bottom, and reflexed closely appressed lobes often deciduous from the ripe fruit; flesh thick, orange color, soft and mealy, nutlets two to four, usually three, narrowed and rounded at the ends, rather broader at the apex than at the base, ridged on the back with a high rounded ridge, 7 to 8 mm long and 4.5 mm wide, the broad hypostyle extending to just below the middle of the nutlet.

A broad shrub 3 to 4 m high, with erect stems, and stout zigzag branchlets light yellow-green when they first appear, becoming light chestnut-brown, very lustrous and marked by large dark lenticels at the end of their first season and pale gray the following year, and armed with numerous stout straight light chestnut-brown shining spines 3 to 4.5 cm long.

Rocky banks on the north side of the Mohawk river below Little Falls; J. V. Haberer (no. 2491, type), June 1, 1912; Haberer and Dunbar, September 22, 1912. Moss island in the Mohawk river,

below Little Falls; J. V. Haberer (no. 2416), June 1, 1912; Haberer, Dunbar and Sargent, September 27, 1912.

This species is named in memory of Miss Mary Isabel Haberer, the companion and assistant of her father in his botanical explorations of the flora of central New York.

Crataegus macauleyae Sargent

Proc. Rochester Acad. Sci. IV. 130 (1903).

Chapinville and Rochester.

Crataegus noveboracensis Sargent

N. Y. State Mus. Bul. 116. 22 (1907).

North Elba and Keene.

Crataegus verrucalis Peck

N. Y. State Mus. Bul. 122. 123 (1908).

Adirondack region.

Crataegus puberis Sargent

N. Y. State Mus. Bul. 105. 73 (1906).

Near Belfast.

Crataegus proctoriana n. sp.

Leaves ovate, acute or acuminate, abruptly or broadly cuneate at the base, coarsely often doubly serrate with straight glandular teeth, and deeply divided into four or five pairs of narrow acuminate spreading or often slightly recurved lobes; about half grown when the flowers open the first of June and then thin, yellow-green, roughened above by short white hairs and glabrous below, and at maturity thin but firm in texture, dark, yellow-green and smooth or scabrate on the upper surface, pale yellow-green on the lower surface, 5 to 7 cm long and 4 to 6 cm wide, with slender midribs, and thin primary veins extending obliquely to the points of the lobes; petioles slender, slightly wing-margined at the apex, glandular with occasional small persistent glands, 2 to 2.5 cm in length; leaves on vigorous shoots ovate, acuminate, abruptly cuneate, rounded or truncate at the wide base, coarsely serrate, deeply lobed, often 9 to 10 cm long and 8 to 9 cm wide, their petioles stout, narrowly wing-margined often to the middle, conspicuously glandular, 2.5 to 3 cm in length. Flowers 1.3 to 1.5 cm in diameter, on slender slightly hairy pedicels, in

narrow mostly 8–10-flowered sparingly villose corymbs, the lower peduncles from the axils of upper leaves; calyx-tube narrowly obconic, covered at the base with long scattered white hairs, the lobes separated by wide sinuses, glabrous on the outer surface, slightly villose on the inner surface; stamens ten; anthers pink in the bud, fading white as the flowers open; styles three or four. Fruit ripening the end of September on slender pedicels, in few-fruited clusters, subglobose but often slightly longer than broad, crimson, lustrous, marked by large pale dots, 1 to 1.2 cm in diameter; calyx little enlarged, with a broad shallow cavity and reflexed appressed lobes; flesh thin, dry and mealy; nutlets three or four, rounded at the ends, rather broader at the apex than at the base, ridged on the back with a high deeply grooved ridge 7 to 8 mm long and about 4 mm wide, the broad conspicuous hypostyle extending to just below the middle of the nutlet.

A broad shrub 5 to 6 m high, with stout stems covered with dark scaly bark, erect spreading branches, and slender slightly zizag branchlets tinged with red and marked by numerous pale lenticels when they first appear, becoming dark chestnut-brown and lustrous at the end of their first season and ashy gray the following year, and armed with stout straight or slightly curved chestnut-brown shining spines 3 to 4.5 cm. long.

Swampy hilltops south of Utica, rare; J. V. Haberer (no. 2412, type), June 4, September 22 and October 6, 1907, September 19, 1912; Haberer, Dunbar and Sargent, September 28, 1912.

This interesting species is named for Thomas Redfield Proctor, a public-spirited citizen of Utica to whose generosity the city owes its public parks, covering an area of some five hundred acres.

Crataegus maligna n. sp.

Leaves elliptical to slightly obovate, acute or acuminate, gradually narrowed and cuneate or rounded at the base, finely serrate with straight glandular teeth, and divided above the middle into three or four pairs of short broad acute lobes; nearly fully grown when the flowers open the middle of June and then yellow-green and roughened above by short white hairs and glabrous below, and at maturity thin but firm in texture, glabrous, dark yellow-green on the upper surface, pale on the lower surface, 4 to 4.5 cm long and 3 to 3.5 cm wide, with thin midribs and primary veins; petioles slender, slightly wing-margined at the apex, glabrous, occasionally glandular, 1.5 to 2 cm in length; leaves on vigorous shoots ovate, rounded or abruptly

cuneate at the wide base, 4.5 to 5 cm long and broad. Flowers 1.8 cm in diameter, on slender slightly villose pedicels, in wide mostly 15–20-flowered corymbs, the lower peduncles from the axils of upper leaves; calyx-tube narrowly obconic, slightly villose at the base, the lobes separated by wide sinuses, broad, acuminate, glandular-serrate, glabrous on the outer surface, villose on the inner surface, reflexed after anthesis; stamens five to ten; anthers pink; styles three or four, surrounded at the base by a narrow ring of white hairs. Fruit ripening the end of September on drooping red pedicels, short-oblong, slightly narrowed and rounded at the base, crimson, lustrous, marked by occasional pale dots, 1.2 to 1.3 cm long and 9 to 10 mm in diameter; calyx prominent with a short tube, a very deep narrow cavity pointed in the bottom, and reflexed appressed persistent lobes; flesh thin, dry and mealy; nutlets three or four, acute at the apex, broader and rounded at the base, ridged on the back with a low ridge, occasionally depressed on the inner surfaces, 7 to 7.5 mm long and 4 to 4.5 mm wide, the broad prominent hypostyle extending to just below the middle of the nutlet.

A shrub 3 to 4 m tall, with ascending stems covered at the base with scaly bark, ascending branches forming a compact head, and stout slightly zigzag glabrous branchlets light orange-green when they first appear, bright chestnut-brown, lustrous and marked by large pale lenticels at the end of their first season and dull gray-brown the following year, and armed with numerous slender straight chestnut-brown shining spines 7 to 8 cm long.

Open pastures in moist soil near Ogdensburg. J. Dunbar (no. 49, type), June 12 and September 28, 1907.

A slight depression which occurs on the inner faces of some of the nutlets indicates the relationship of this very distinct species with the Anomalae, but such depressions are not constant and in other characters it is more like the Rotundifoliae with which I have placed it rather than with the Anomalae.

Crataegus praecoqua Sargent

Rhodora V. 167 (1903).

Crataegus praecox Sargent. Rhodora III. 27 (not Loudon) (1902).

Crown Point, Fort Ann; also in northern Illinois, Wisconsin and the Province of Quebec.

Crataegus spissa Sargent

N. Y State Mus. Bul. 122. 122 (1908).

North Elba.

Crataegus chateaugayensis Sargent

N. Y. State Mus. Bul. 122. 121 (1908).

Near Chateaugay lake.

Crataegus harryi Sargent

N. Y. State Mus. Bul. 122. 124 (1908).

Richmond, Canadice lake and Honeoye lake.

Crataegus neo-baxteri Sargent

N. Y State Mus. Bul. 122. 74 (1908).

Tuscarora.

ANOMALAE

Crataegus saundersiana Sargent

Ontario Nat. Sci. Bul. 4. 66 (1908).

Palmyra; also in southern Ontario.

Crataegus brachyloba Sargent

N. Y. State Mus. Bul. 122. 75 (1908).

Buffalo.

Crataegus fallsiana n. sp.

Leaves obovate to ovate, acuminate, gradually or abruptly narrowed at the entire base, sharply and often doubly serrate above, with straight glandular teeth and divided above the middle into four or five pairs of short acute lobes; nearly one-third grown when the flowers open about the 10th of June and then yellow-green and roughened above by short white hairs and paler and glabrous below, and at maturity glabrous, dark yellow-green on the upper surface, light yellow-green on the lower surface, 6 to 10 cm long and 5 to 7 cm wide, with stout midribs and slender primary veins; petioles slender, wing-margined at the apex, glabrous, dark red in the autumn, 3 to 4 cm in length. Flowers 3 cm in diameter, on long slender glabrous pedicels, in wide lax mostly 6–10-flowered corymbs, the elongated lower peduncles from the axils of upper leaves; calyx-tube narrowly obconic, glabrous, its lobes gradually narrowed to the base, long, slender, acuminate, entire or slightly dentate near the middle, glabrous on the outer surface, villose on

the inner surface, reflexed after anthesis; stamens twenty; anthers rose color; styles three to five. Fruit ripening the end of September on drooping pedicels, subglobose, truncate at the ends, slightly angled, scarlet, lustrous, marked by small pale dots, 1.4 to 1.5 cm in diameter; calyx little enlarged with a deep narrow cavity, and spreading and erect lobes often deciduous from the ripe fruit; flesh orange color, of good flavor; nutlets three to five, rounded at the ends, broader at the base than at the apex, ridged on the back with a wide grooved ridge, slightly and irregularly depressed on the inner faces, 7 to 8 mm long and 4 to 5 mm wide, the prominent hypostyle extending to below the middle of the nutlet.

An arborescent shrub or small tree sometimes 7 m high, with a stem 15 cm in diameter at the base, bark covered with small dark gray-brown scales, stout pale gray branches, and slender slightly zigzag branchlets light orange-color when they first appear, becoming light chestnut-brown, lustrous, and marked by numerous pale lenticels at the end of their first season, and armed with stout straight or slightly curved chestnut-brown shining spines 3.5 to 4.5 cm long.

Top of Falls hill south of the Mohawk at Little Falls, J. V. Haberer (no. 2464, type), June 12, 1912; Haberer, Dunbar and Sargent, September 27, 1912.

Crataegus dunbarii Sargent

Proc. Rochester Acad. Sci. IV. 126 (1903); N. Y. State Mus. Bul. 122. 76 (1908).

Rochester, Hemlock lake, Adams Basin and Buffalo.

Crataegus inopinata Sargent

N. Y. State Mus. Bul. 122. 108 (1908).

Coopers Plains.

Crataegus scabrida Sargent

Rhodora III. 29 (1901); Silva N. Am. XIII. 133, t. 677; N. Y State Mus. Bul. 122. 76 (1908).

Albany, Little Falls, New Hartford, Mohawk, near Utica, Hemlock lake, Belfast; also in New England, the Province of Quebec and southern Ontario.

Crataegus affinis Sargent

Ontario Nat. Sci. Bul. 4. 71 (1908).

Piseco, Hamilton co.; also near Toronto, Ontario.

Crataegus misella n. sp.

Leaves rhombic to obovate, acuminate and long-pointed at the apex, gradually narrowed and cuneate at the entire base, finely doubly serrate above with straight glandular teeth, and divided above the middle into three or four pairs of small acuminate spreading lobes; nearly fully grown when the flowers open at the end of May and then thin, yellow-green, roughened above by short white hairs and glabrous below, and at maturity thin, yellow-green, scabrate on the upper surface, paler on the lower surface, 5 to 6 cm long and 3.5 to 4 cm wide, with slender midribs, and thin primary veins extending obliquely to the points of the lobes; petioles slender, narrowly wing-margined at the apex, villose on the upper side while young, soon glabrous, 2 to 2.5 cm in length; leaves on vigorous shoots narrowed and rounded at the base, coarsely serrate, more deeply lobed and sometimes 6 cm long and 5 cm wide. Flowers 1.5 to 1.7 cm in diameter, on slender slightly villose pedicels, in 6–15-flowered corymbs, the lower peduncles from the axils of upper leaves; calyx-tube narrowly obconic, glabrous or slightly villose, the lobes slender, acuminate, glandular-dentate, glabrous on the outer, villose on the inner surface, reflexed after anthesis; stamens five to seven; anthers rose color; styles three or four, surrounded at the base by a ring of pale hairs. Fruit ripening the middle of September on red pedicels, in erect clusters, short-oblong, rounded at the ends, crimson, marked by small pale dots, 1.2 cm long and 1 cm in diameter; calyx little enlarged with a deep cavity pointed in the bottom, and spreading closely appressed lobes; flesh thin, yellow, firm and bitter; nutlets three or four, rounded at the ends, broader at the base than at the apex, rounded and ridged on the back with a broad high ridge, usually irregularly depressed on the inner faces, 6 to 7 mm long and 3 to 4 mm wide, the narrow hypostyle extending nearly to the base of the nutlet.

A shrub 3 to 4 m high, with ascending stems and branches, and slender glabrous slightly zigzag branchlets tinged with red and marked by pale lenticels when they first appear, becoming chestnut-brown and lustrous at the end of their first season and dull gray-brown the following year, and armed with stout slightly curved chestnut-brown shining spines 4 to 5 cm long.

On hillsides in clay soil, near Belfast, Allegany county; Baxter and Dewing (no. 216, type), September 14, 1904, May 28 and September 17, 1905.

Crataegus asperifolia Sargent

Rhodora III 31 (1901); N. Y. State Mus. Bul. 105. 64 (1906).

Near Albany, Little Falls, Buffalo, Coopers Plains; also in New England, southern Ontario and the Province of Quebec.

Crataegus singularis Sargent, N. Y. State Mus. Bul. 122. 106 (1908), with more deeply lobed leaves can not otherwise be distinguished from Crataegus asperifolia and probably should be referred to that species.

Crataegus repulsans Sargent

N. Y. State Mus. Bul. 122. 107 (1908).

Coopers Plains.

Crataegus floridula Sargent

N. Y. State Mus. Bul. 122. 126 (1908).

Piseco.

Crataegus knieskerniana n. sp.

Glabrous with the exception of the hairs on the young leaves and calyx-lobes. Leaves ovate, acuminate, cuneate at the entire base, coarsely doubly serrate above with straight glandular teeth, and divided into five or six pairs of narrow acuminate lateral lobes; about one-third grown when the flowers open the end of May and then thin, dark yellow-green and roughened above by short white hairs and pale bluish green and glabrous below, and at maturity thin, yellow-green, smooth and lustrous on the upper surface, paler on the lower surface, 6 to 7 cm long and 4.5 to 5 cm wide, with thin midribs, and slender primary veins extending obliquely to the points of the lobes; pedicels slender, slightly wing-margined at the apex, red in the autumn, 2.5 to 3 cm in length; leaves on vigorous shoots ovate, acuminate, rounded, subcordate or occasionally cuneate at the broad base, coarsely serrate, more deeply lobed, 8 to 9 cm long and wide with glandular petioles. Flowers 1.5 to 1.8 cm in diameter, on long slender pedicels, in wide lax mostly 10–13-flowered corymbs, the thin much elongated lower peduncles from the axils of upper leaves; calyx-tube narrowly obconic, the lobes long, slender, acuminate, entire, slightly dentate near the middle, glabrous on the outer, villose on the inner surface, reflexed after anthesis; stamens ten; anthers rose color; styles three or four. Fruit ripening in October on slender drooping pedicels, short-oblong, rounded at the ends, scarlet, lustrous, marked by large pale dots, 1.3 to 1.4 cm long, 1 to 1.1 cm in diameter; calyx little enlarged, with a deep narrow cavity

pointed in the bottom and spreading closely appressed lobes; flesh thin, yellow, dry and mealy; nutlets three or four, pointed at the apex, broader and rounded at the base, rounded and slightly ridged on the back, conspicuously depressed on the inner faces, 7 to 8 mm long and 4 to 5 mm wide, the narrow hypostyle extending nearly to the base of the nutlet.

A broad-topped shrub 2 to 4 m high, with stout stems covered with dark gray bark, and slender only slightly zigzag branchlets, light orange-brown and marked by pale lenticels when they first appear, becoming dark chestnut-brown and lustrous at the end of their first season and dull brown the following year, and armed with many slender straight or slightly curved chestnut-brown shining spines 3.5 to 5 cm long.

In gravelly soil along the top of the cliffs of West Canada creek north of East Herkimer; J. V. Haberer (no. 2524, type), May 28 and October 3, 1912.

This species differs from the other described species of Anomalae in the broad rounded or subcordate base of the leaves on the vigorous shoots. It is named in memory of Peter D. Knieskern (1798–1871), at one time a resident of Oriskany, New York, author of "A Catalogue of the Plants found in Oneida County," "an indefatigable collector, a keen observer, unsurpassed by few botanists in his knowledge of the plants of the region in which he resided."

TOMENTOSAE

Crataegus tomentosa Linnaeus

Spec. 467 (1753). Sargent, Silva N. Am. IV. 101, t. 183.

Watervliet, near Elmira, Ithaca, Chapinville, Hemlock lake, Coopers Plains, Geneseo, Buffalo, Salamanca; also to Missouri and North Carolina.

Crataegus efferata Sargent

N. Y. State Mus Bul. 122. 128 (1908).

Hemlock lake.

Crataegus diversa Sargent

N. Y. State Mus. Bul. 122. 109 (1908).

Coopers Plains.

Crataegus finitima Sargent

N. Y. State Mus. Bul. 122. 78 (1908).

Ithaca, near Utica, Belfast, Tuscarora and Niagara Falls.

Crataegus spinifera Sargent

N Y. State Mus. Bul. 122. 118 (1908).

Canandaigua, Coopers Plains and Hemlock lake.

Crataegus menandiana Sargent

N. Y. State Mus. Bul. 105. 68 (1906).

Albany.

Crataegus structilis Ashe

Jour. Elisha Mitchell Sci. Soc. XIX. 12 (1903). Sargent, N. Y. State Mus. Bul. 122. 77 (1908).

Chapinville, Rochester, Hemlock lake, Coopers Plains, Salamanca; also in eastern Pennsylvania, southern Ontario and in Michigan.

Crataegus comans Sargent

N. Y. State Mus. Bul. 122 112 (1908).

Coopers Plains.

Crataegus truculenta n. sp.

Leaves obovate, acuminate, gradually narrowed to the entire base, finely doubly serrate above with straight glandular teeth, and divided above the middle into four to six pairs of small broad acute lobes; nearly fully grown when the flowers open the first week of June and then yellow-green and scabrate above, paler and soft pubescent below, and at maturity thick, dark yellow-green and nearly smooth on the upper surface, pale yellow-green and slightly villose along the thin midribs and primary veins on the lower surface, 5.5 to 6 cm long and 3.5 to 4 cm wide; petioles slender, wing-margined at the apex, villose on the upper side early in the season, becoming glabrous, 1 to 1.2 cm in length; leaves on vigorous shoots broadly ovate to elliptical, acuminate, gradually narrowed and rounded or cuneate at the base, more coarsely serrate and more deeply lobed, and 6.5 to 8 cm long and 6 to 6.5 cm wide, their petioles stout, broadly wing-margined to below the middle, 1 to 1.2 cm in length. Flowers 1.2 to 1.4 cm in diameter, on long slender villose pedicels, in wide 20–25-flowered corymbs, the much elongated lower peduncles from the axils of upper leaves; calyx-tube narrowly obconic, coated at the base with long white hairs, the lobes long, broad, acuminate, laciniately divided, glabrous on the outer surface, slightly villose on the inner surface, reflexed after anthesis; stamens twenty; anthers yellow; styles two or three. Fruit on erect nearly glabrous

pedicles, in board 5–15-fruited clusters, subglobose, dark red, marked by large pale dots, 7 to 8 mm in diameter; calyx prominent, with a wide shallow cavity broad in the bottom, and spreading and reflexed enlarged persistent lobes; flesh thin, firm and dry; nutlets two or three, pointed at the apex, rounded at the base, ridged on the back with a broad grooved ridge, penetrated on the inner faces by deep narrow cavities, 6 to 7 mm long and 3 to 5 mm wide.

A shrub 4 to 5 m high, with erect gray stems and branches, and slender, glabrous branchlets tinged with red and marked by pale lenticels when they first appear, becoming bright chestnut-brown and lustrous, and armed with numerous slender straight or slightly curved dark chestnut-brown shining spines 3.5 to 6 cm long.

In thickets in heavy clay soil, near Belfast, Allegany county, Baxter and Dewing (no. 214, type), May 30, 1903, September 14, 1904, September 19, 1905.

Crataegus ambrosia Sargent

N. Y. State Mus. Bul. 105. 69 (1906).

Albany.

Crataegus rhombifolia Sargent

Rhodora V. 183 (1903); N. Y. State Mus. Bul. 105. 71 (1906).

Crown Point, Whitehall, near Albany; also in western and southern New England.

Crataegus deweyana Sargent

Proc. Rochester Acad. Sci. IV. 133 (1903).

Ithaca, Rochester, Rush, Portage, Castile and Silver Springs.

Crataegus cupulifera Sargent

Proc. Rochester Acad. Sci. IV. 129 (1903).

Crataegus simulans Sargent. N. Y. State Mus. Bul. 122. 125 (1908).

Chapinville, Rochester, Hemlock lake and Coopers Plains.

Crataegus balkwillii Sargent

Ontario Nat. Sci. Bul. 4. 80 (1908).

Chapinville; also in southern Ontario.

Crataegus microsperma Sargent

Ontario Nat. Sci. Bul. 4. 82 (1908)

Little Falls, Coopers Plains; also in southern Ontario.

Crataegus flagrans Sargent

N. Y. State Mus. Bul. 105. 71 (1906).

North Greenbush.

Crataegus venustula Sargent

N. Y. State Mus. Bul. 122. 79 (1908).

Niagara Falls, Buffalo; also in southern Ontario.

Crataegus laneyi Sargent

Trees and Shrubs. I. 5, t. 3 (1902); Proc. Rochester Acad. Sci. IV. 136 (1903).

Near Herkimer, Rochester and Coopers Plains.

Crataegus succulenta Link

Handbook II. 76 (1811). Sargent, Silva N. Am. XIII. 139, t. 131.

Chapinville, Rochester, Belfast, Niagara Falls, Buffalo, Palmyra, Salamanca; also in southern New England, eastern and western Pennsylvania and southern Ontario.

Crataegus gemmosa Sargent

Bot. Gazette XXXIII. 119 (1902); Silva N. Am. XXIII. 141, t. 686; N. Y. State Mus. Bul. 105. 72 (1906).

Near Albany, Rochester, Hemlock lake; also in southern Ontario, Ohio and Michigan.

Crataegus calvinii Sargent

N. Y. State Mus. Bul. 122. 81 (1908).

Chapinville and Canandaigua.

Crataegus sonnenbergensis n. sp.

Leaves obovate, abruptly narrowed and acute at the apex, gradually narrowed and cuneate at the entire base, finely often doubly serrate above with straight teeth pointing toward the apex of the leaf, and slightly and irregularly divided above the middle into short acute lobes; more than half grown when the flowers open during the first week in June and then thin, glabrous and lustrous above and pale and covered below with short soft hairs most abundant on the midribs and veins, and at maturity 6 to 7 cm long and 4.5 to 5 cm wide, thick, dark blue-green and lustrous on the upper surface,

pale blue-green and still slightly villose below along the prominent midribs, and six to eight pairs of thin conspicuous primary veins extending obliquely to above the middle of the leaf; petioles stout, narrowly wing-margined often to below the middle, tinged with red late in the season, 1.5 to 2.5 cm in length. Flowers 1.5 cm in diameter, on long slender villose pedicels, in lax few-flowered slightly hairy corymbs, the lower peduncles from the axils of upper leaves; calyx-tube narrowly obconic, covered with long pale hairs, the lobes slender, acuminate, glandular-serrate, glabrous on the outer, puberulous on the inner surface, reflexed after anthesis; stamens twenty; anthers pink; styles two. Fruit ripening the middle of October, on long slender red pedicels slightly villose near the apex, subglobose to short-oblong, crimson, lustrous, about 1 cm in diameter; calyx little enlarged, with a deep narrow cavity pointed in the bottom, the lobes generally deciduous from the ripe fruit; flesh yellow, becoming soft and succulent when the fruit is fully ripe; nutlets two, rounded at the obtuse ends, ridged on the back with a low rounded ridge, about 5 mm long and 3 mm wide, penetrated on the inner face by deep narrow cavities.

An arborescent shrub with stems spreading into great clumps, 5 to 10 m high, 30 cm in diameter and covered with very dark brown bark broken into small closely appressed scales, ascending branches, and slender glabrous branchlets pale yellow-green early in the season, becoming bright reddish brown before autumn, and armed with stout slightly curved spines 4 to 5 cm long.

Open pastures in heavy soil on Sonnenberg, the beautiful Thompson estate at Canandaigua, Ontario county; R. H. Slavin (no. 51, type), June 3 and October 15, 1909.

Crataegus frutescens Sargent

N. Y. State Mus. Bul. 122. 113 (1908).

Coopers Plains.

Crataegus honeoyensis Sargent

N. Y. State Mus. Bul. 122. 129 (1908).

Honeoye lake, Hemlock lake and Campbell.

Crataegus admiranda Sargent

N. Y. State Mus. Bul. 122. 80 (1908).

Niagara Falls.

Crataegus spinea n. sp.

Glabrous with the exception of the hairs on the inner surface of the calyx-lobes. Leaves rhombic, acute at the ends, finely serrate, often only above the middle, with straight glandular teeth, and slightly divided into three or four pairs of broad acuminate lobes; nearly fully grown when the flowers open at the end of May and then light yellow-green above and pale blue-green below, and at maturity thick, dark green and lustrous on the upper surface, pale on the lower surface, 4 to 5 cm long and 2 to 3 cm wide, with prominent midribs and veins deeply impressed on the upper side; petioles slender, wing-margined nearly to the base, 7 to 10 mm in length. Flowers 1.3 to 1.8 cm in diameter, on long slender pedicels, in lax 15–22-flowered corymbs, the elongated lower peduncles from the axils of upper leaves; calyx-tube narrowly obconic, the lobes gradually narrowed from the base, wide, acuminate, laciniately glandular-serrate, reflexed after anthesis; stamens twenty; anthers small, rose color; styles two to four, mostly two or three. Fruit on erect pedicels, in broad clusters, subglobose to short-oblong, dark red, lustrous, marked by dark spots, 6 to 7 mm in diameter; calyx prominent with a short tube, a wide shallow cavity pointed in the bottom, and reflexed persistent lobes dark red on the upper side below the middle; flesh yellow, dry and mealy; nutlets usually two or three, rounded at the ends, ridged on the back with a narrow rounded ridge, penetrated on the inner faces by long deep narrow cavities, 4 to 4.5 mm long and 3 to 3.5 mm wide, the narrow hypostyle extending to the middle of the nutlet.

A round-headed shrub 3 to 4 m high, with stout stems spreading into large clumps and covered at the base with dark gray-brown checkered bark, ascending branches, and stout nearly straight branchlets orange-green and marked by large pale lenticels when they first appear, becoming light chestnut-brown and lustrous at the end of their first season and dull red-brown the following year, and armed with numerous slender straight dark chestnut-brown shining spines 5 to 7 cm long.

Low moist hillsides near Campbell; G. D. Cornell (no. 124, type), October 5, 1907, May 26, 1908.

Crataegus halliana Sargent

N. Y. State Mus. Bul. 105. 73 (1906).

Near Albany.

Crataegus conspicua Sargent

N. Y. State Mus. Bul. 105. 74 (1906).

Near Albany; also in western Vermont.

Crataegus beckiana Sargent

N. Y. State Mus. Bul. 105. 75 (1906).

North Greenbush.

Crataegus ogdensburgensis n. sp.

Leaves ovate to obovate, acute or acuminate, gradually narrowed and concave-cuneate at the entire base, sharply doubly serrate above with straight glandular teeth, and slightly divided above the middle into small acuminate lobes; fully grown when the flowers open in the first week of June and then thin, yellow-green, covered above by soft hairs and slightly villose along the midribs and veins below, and at maturity thick, dark green, smooth and lustrous on the upper surface, pale and nearly glabrous on the lower surface, 5 to 7 cm long and 4 to 5 cm wide, with stout rose colored midribs, and slender primary veins extending obliquely to the points of the lobes; petioles stout, wing-margined to the base, slightly villose on the upper side early in the season, soon becoming glabrous, 1 to 1.5 cm in length; stipules lanceolate, acuminate, slightly falcate, glandular-serrate, often persistent until the flowers open; leaves on vigorous shoots broadly ovate, often 9 to 10 cm long and 6 to 7 cm wide. Flowers 1.5 to 1.7 cm in diameter, on long slender slightly villose pedicels, in wide lax mostly 16–18-flowered corymbs, the lower peduncles from the axils of upper leaves; calyx-tube narrowly obconic, the lobes broad, long-acuminate, laciniately glandular-serrate, glabrous on the outer surface, villose on the inner surface, reflexed after anthesis; stamens ten; anthers pale pink; styles two or three. Fruit ripening the end of September on long pedicels, in wide drooping many-fruited clusters, subglobose to short-oblong, rounded at the ends, crimson, lustrous, marked by large pale dots, 9 to 11 cm in diameter; calyx prominent, with a short tube, a wide shallow cavity pointed in the bottom, and reflexed closely appressed persistent lobes dark red on the upper side below the middle; flesh thick, soft and succulent; nutlets two or three, rounded at the ends, rounded and slightly ridged on the back, penetrated on the inner faces by short narrow cavities, 6 to 7

mm long and 3 to 3.5 mm wide, the narrow hypostyle extending to below the middle of the nutlet.

A shrub 3 to 4 m high, with spreading ashy gray branches forming an open head, and stout slightly zigzag glabrous branchlets light orange-green when they first appear, becoming light chestnut-brown, lustrous and marked by pale lenticels at the end of their first season and unarmed or armed with occasional spines.

Rich pastures near Ogdensburg; J. Dunbar (no. 71, type), September 28, 1907, June 5, 1908.

Crataegus ferentaria Sargent

Proc. Rochester Acad. Sci. IV. 135 (1903); N. Y. State Mus. Bul. 105. 77 (1906).

Fort Ann, Albany, Frankfort, near Utica, Canandaigua, Rochester, Belfast, Coopers Plains, Buffalo; also in New England.

Crataegus hystricina Ashe

Bot. Gazette XXXV. 433 (1903). Sargent, N. Y. State Mus. Bul. 105. 77 (1906).

Near Albany; also in southern Connecticut.

Crataegus macracantha Koehne

Deutsche Dendr. 236 (1893). Sargent, Silva N. Am. XIII. 147, t. 689; Proc Rochester Acad. Sci. IV. 135 (1903).

Ithaca, Rochester; also in New England and eastern Pennsylvania.

EXPLANATION OF PLATES

Plate 131

125

Amanita ovoidea Bull.

OVOID AMANITA

1 Plant with cap beginning to expand. About ½ natural size
2 Half vertical section of a pileus. About ½ natural size
3 Four spores x 400

AMANITA OVOIDEA BULL.
OVOID AMANITA

Plate 132

127

Tricholoma chrysenteroides Pk.

GOLDEN FLESH TRICHOLOMA

1, 2 Immature plants
3 Mature plant
4 Old plant
5 Vertical section of the upper part of an immature plant
6 Four spores x 400

TRICHOLOMA CHRYSENTEROIDES Pk.
GOLDEN FLESH TRICHOLOMA

Plate IX

Russula ballouii Pk.

BALLOU RUSSULA

1 Plant showing upper surface of pileus and stem
2 Plant showing both upper and lower surface of pileus and stem
3 Vertical section showing half of the upper part of a plant
4 Four spores x 400

Tricholoma latum Pk.

BROAD CAP TRICHOLOMA

5 Immature plant
6 Mature plant
7 Vertical section of the upper part of an immature plant
8 Four spores x 400

FIG. 1-4
RUSSULA BALLOUII PK.
BALLOU RUSSULA

FIG. 5-8
TRICHOLOMA LATUM PK.
BROAD CAP TRICHOLOMA

Plate X

Mycena splendidipes Pk.

POISON MYCENA

1 Tuft of three very young plants
2 Immature plant
3 Single mature plant
4 Tuft of three mature plants and one very young plant
5 Mature plants with very long stems
6 Vertical section of the upper part of an immature plant

MYCENA SPLENDIDIPES Pk.
POISON MYCENA

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THE GEOLOGICAL HISTORY OF NEW YORK STATE

BY

WILLIAM J. MILLER

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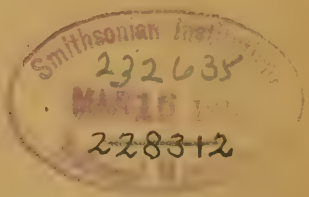

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Science Division, February 28, 1913

Hon. Andrew S. Draper LL.D.
Commissioner of Education

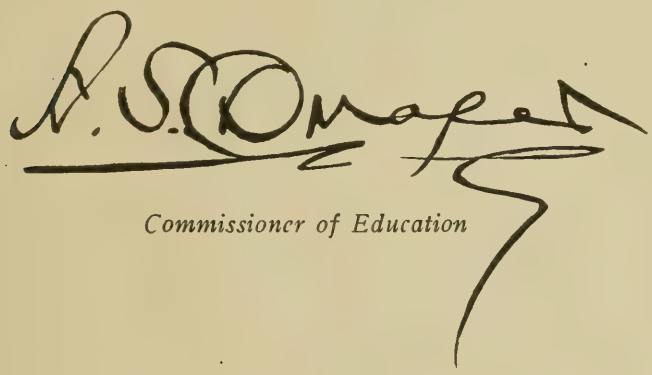
SIR: I have the honor to submit herewith, and to recommend for publication as a bulletin of the State Museum, a manuscript entitled *The Geological History of New York State,* which has been prepared at my request by Dr William J. Miller, a member of the expert staff of this Division.

This work brings together in compact for a resumé of the geological events in the development of the State, and for such a publication as this there is at the present time a widespread demand

Very respectfully
JOHN M. CLARKE
Director

STATE OF NEW YORK
EDUCATION DEPARTMENT
COMMISSIONER'S ROOM

Approved for publication this
17th day of March 1913



Commissioner of Education

Taughannock Falls (height 215 feet) which ranks as the highest true waterfall in New York State. Located near Trumansburg, Tompkins county. The rocks are Devonic sandstones and sandy shales and the postglacial gorge just below the falls is nearly 400 feet deep.

Photo loaned by H. R. Head, Ithaca, N. Y.

Compliments of

JOHN M. CLARKE

Director State Museum and
State Geologist

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John M. Clarke, Director

Museum Bulletin 168

THE GEOLOGICAL HISTORY OF NEW YORK STATE

BY

WILLIAM J. MILLER Ph.D.

PREFACE

The researches and truths of any modern science if they are properly to fulfil their mission, should be brought within the reach of laymen. In this bulletin the purpose is to present in a simple, readable form, an outline of the wonderful story of the physical development of New York State. No knowledge of physiography or geology is presupposed. Any person who possessed of intelligence and a willingness to learn is fully prepared to read these pages.

When the reader has gained a fair understanding of the principles here set forth, he will be much better prepared to use intelligently the publications of the New York State Museum which deal with the geology and geography of many portions of the State. In short, this volume may be considered as a "first book" for all who are interested in the physical features of our State and it is believed that teachers and older pupils in geography and physical geography may receive helpful suggestions from it.

It must be clearly understood that scarcely more than a sketch of such a large subject can be given in so brief a space. Local

details can seldom be brought in except for illustration of certain important points, and of necessity many questions will occur to readers interested in the natural features of their home regions which are not directly answered. It is hoped, however, that most of the important and striking geographic features in all parts of the State are explained, and that many local details will find ready explanation by the application of the principles set forth.

Emphasis is here placed upon the genesis of geographic forms. It is one thing merely to state a geographic fact, such as the location of a mountain or lake or valley, but it is a far different thing to explain how the mountain or lake or valley came to be there. Every geographic form has a history, and if we fail to appreciate that history we lose the most interesting and valuable part of our geographic training. Geographic facts, like all others, are more easily understood and remembered when the reasons for their existence are given, yet it must be admitted that the teaching of such rational geography is still in its infancy in the schools of this State.

The use of a certain number of scientific terms is unavoidable in practice, but common terms only are employed and in every case these are carefully explained when first used in the text. Particular attention is directed to the photographs, maps and diagrams, all of which have been carefully selected or made for the express purpose of illustrating this text. Except for some quotations, references to original papers have been omitted, but at the end of the volume a list of the more important books and papers of general interest is given, and anyone desiring to broaden into wider fields or greater details can readily do so with the aid of those references.

I have used many personal observations made during travels into almost every county of the State, but obviously the book could never have been written were it not for scores of devoted men of science who, during the last hundred years, have zealously labored to unravel the natural history of our great Commonwealth. I gratefully acknowledge my indebtedness to them all.

I am under particular obligation to Dr J. M. Clarke, our able and efficient State Geologist and Director of Science, for his kindness in critically reading the manuscript and making important corrections and suggestions.

W. J. M.

Hamilton College, Clinton, N. Y.

Chapter 1

INTRODUCTION

GENERAL PRINCIPLES AND REFERENCE TABLES

Few states present a more wonderful variety of physical features or afford a more excellent opportunity to those interested in the study and teaching of geography or geology than does New York. Here are rock formations of all the more important types; all the leading types of mountains (Adirondacks, Catskills, and Taconics) except actual volcanoes, and even true lavas occur in the Adirondacks and in the Palisades of the Hudson; hundreds of lakes of various shapes and kinds; shore outlines ranging from the great sand bars and beaches of Long Island to wave-worn cliffs along the shores of Lake Erie and Lake Ontario; typical prairie plains like that south of Lake Ontario; a great plateau in the southwestern region; valleys and gorges of varied origin; rivers of all types and often with remarkable histories; a striking display of relief features; and extensive and varied deposits of glacial origin. Accordingly, it is not an exaggeration to say that examples of nearly all the most important physical features of the earth are represented within the borders of this State.

As the observer looks out over the State he sees this great variety of physical features and, unless he has given some thought to the subject, is very likely to regard these as practically unchangeable, and that they are now essentially as they were in the beginning of the earth's history. Some of the fundamental ideas taught in this book are that the physical features of the State, as we behold them today, represent but a single phase of a very long continued history; that significant changes are now going on all around us; and that we are able to interpret the geography of the present only by an understanding of its changes in the past.

Geology is concerned with the evolution of the earth and of its inhabitants, as revealed in the rocks. This science is very broad in its scope and treats of the processes by which the earth has been, and is now being, changed; the structure of the earth; the stages through which it has passed, and the development of the organisms which have lived upon it.

Geography deals with the distribution of the earth's physical features, in their relation to each other, to the life of sea and land and human life and culture.

Geography is the outward and present expression of geological

effects. The terms geography and geology are thus here used in the sense that the latter includes the former, as the cause includes the effect. *Paleogeography* has reference to the geography of the past epochs in the history of the earth.

Physiography, or physical geography, deals with the configuration (relief) of the earth's surface and how it was produced.

As a result of the work of many able students of earth science during the past hundred years, it is now well established that our planet has a clearly recorded history of many millions of years, and that during the lapse of those eons revolutionary changes in geography have occurred; that there has also been from an early stage of the earth's history a vast succession of living beings which have gradually passed from simple into more complex forms and have, in some particulars, reached their highest expression in the organisms of the present time. The geographic changes and the organisms of the ages gone by have left us no abundant evidence of their character and the study of the rock formations has shown that within them we have a fairly complete record of the earth's history.

In the time of Alexander von Humboldt, less than one hundred years ago, the keen student of natural phenomena could carry in his own mind most of what was definitely known of earth history. Today, because of the tremendous growth of the science, it would be a presumption for any man to claim that he knows all of what has been learned about the geological history of even the single State of New York. While it is true that much yet remains to be learned of this old earth, it is a real source of wonderment that man, through the exercise of his highest faculty, has come to know so much about it.

All the rocks of the earth's crust may be divided into three great classes: *igneous, sedimentary,* and *metamorphic.*

Igneous rocks comprise all those which have ever been in a molten condition, and of these we have the volcanic rocks (for example, lavas) which have cooled at or near the surface; plutonic rocks (e. g., granites) which have cooled in great masses at considerable depths below the surface; and the dike rocks, which when molten have been forced into fissures of the earth's crust and there cooled.

Sedimentary rocks comprise all those which have been deposited under water (except for some wind-blown deposits) and are nearly always arranged in layers (stratified). These rocks may be of mechanical origin, such as clay or mud which hardens to shale; sand, which consolidates to sandstone; and gravel, which when cemented becomes conglomerate. Or they may be of organic origin,

such as limestone which is formed by the accumulation of calcareous shells; flint and chert, which are accumulations of silicious shells; coal, which is formed by the accumulation of partly decayed vegetable matter. Or, finally, they may be formed by chemical precipitation, as beds of salt, gypsum, bog iron ore, etc.

Metamorphic rocks comprise both sedimentary and igneous masses which have been greatly changed from their original condition. Thus, under conditions of great pressure and heat, with superheated moisture, sedimentary rocks may become crystalline, as when shale is changed to schist, sandstone to quartzite, or limestone to marble; or an igneous rock may take on a banded structure, due to a rearrangement of its component minerals, and thus become a gneiss.

To the modern student of earth science, the old notion of a "terra firma" is outworn. That idea of a solid, immovable earth could never have emanated from the inhabitants of an earthquake country. In the recent San Francisco earthquake, along a line of several hundred miles, one portion of the Coast Range mountains slipped from two to twenty feet past the other. In Alaska, in 1899, a portion of the coast was bodily elevated forty-seven feet. In Japan in 1891, for a distance of forty miles along a rift in the earth's crust, there was a sudden movement of from two to twenty feet. These are merely striking instances of many of the sudden earth movements of recent years. Hundreds of earthquakes occur yearly in the islands of Japan alone, and it is probably true that the earth is shaking all the time.

There are still other movements which are taking place more slowly and quietly, but which are more significant for our interpretation of the profound geographic changes which have occurred during the millions of years of known earth history. Thus the coast of Norway is rising while that of northern France is sinking. Distinct beaches at different elevations far above the ocean level on the western slope of the southern Andes testify to important changes of level in comparatively recent time. A fine illustration of notable sinking of the land is proved by the drowned character of the lower Hudson valley, and by the fact that the old Hudson channel has been definitely traced, as a distinct trench in the ocean bottom, for one hundred miles eastward from Sandy Hook. That this same region has still more recently been partially re-elevated is indicated by the presence of very young stratified beds of clay and sand which are now raised from seventy to three hundred feet above the river, the elevation increasing northward toward Albany. Actual surveys show that, in the Great Lakes region, a differential

movement of the land is now in progress, the elevation being greater toward the north.

In the succeeding pages evidence will be offered to show that most of New York State has been repeatedly covered by ocean water. It will also be established that where such mountain ranges as the Appalachians, Alps or Himalayas now exist was formerly ocean bottom upon which layers of sediment were being spread out. Those layers of sediments have been bent, crumpled, folded, and greatly elevated above sea level. Thus it is literally true that the great typical mountain ranges of the earth have been born out of the ocean.

Among other important processes of nature which have long been active in modifying the earth, are those of *weathering* and *erosion.* Weathering is brought about by the various atmospheric agencies such as moisture, oxygen, carbonic and other acids, together with changes of temperature, and the result is to cause all rock masses to disintegrate or decay. In this way most soils are produced, and were it not for the process of erosion, soils would be much deeper and more widespread than they now are. Weathering prepares the material which is carried away by the streams, and this transported material is deposited either along the flood plains of the lower stream courses or on the bottom of the lake or ocean into which the streams flow. Every stream, at time of flood, is heavily charged with mud or even coarser sediment which has been derived from the wash of the land of its drainage basin. The very presence of the sediment in the streams proves that the land is being lowered and although, on first thought, it may be supposed that no really great change could be accomplished by this means, nevertheless we must remember that nature has practically infinite time at her disposal so that slowly but surely vast geographic changes are wrought and, perchance, a tremendous canyon like that of the Colorado in Arizona will be carved out by weathering and erosion. The general tendency is for all land masses to wear down to or near sea level and, were it not for renewed uplifts, all land, even including mountain ranges, would long ago have been worn down to near sea level, that is to the condition of *peneplain* (almost a plain). The former lofty Appalachians were thus worn down to the condition of a peneplain which has since been somewhat rejuvenated by elevation. Accordingly, that familiar expression "the everlasting hills" is much more exact when made to read "the everlastingly changing hills."

Still another important process by which the physical features of the earth have often been changed is through *vulcanism,* or

igneous activity in general. By this means materials are brought up from within the earth to or near its surface. Thus an active volcano violently ejects rock fragments, dust etc. or more quietly pours out molten rock, while in many cases great masses of molten rocks have been forced upward into the crust of the earth without reaching the surface and hence have slowly cooled at greater or lesser depths below the surface. Such volcanic rocks have become exposed to view only by subsequent erosion of the region.

In order to understand the physical history of our State it is necessary to know that significant changes, like those above described, have long been, and now are taking place. In tracing this history we shall see how all these natural processes have operated to bring the State into its present condition. It is also necessary to understand that the known history of the earth has been carefully divided into great eras, and into lesser periods and epochs, and that these constitute what is called the geologic time scale. This time scale is important to the reader because the principal events in the history of the State will be taken up, so far as they are recorded, in regular order according to that scale. In the first table the names of eras and periods are mostly of world-wide usage, while the names of subdivisions (epochs) of the periods are much more local in usage and, in the second table, only those are given which apply to New York State.

GEOLOGIC TIME SCALE

ERAS	PERIODS	DOMINANT LIFE
Cenozoic	Quaternary	Age of man
	Tertiary	Age of mammals
Mesozoic	Cretacic, Jurassic	Age of reptiles, with birds first in the Jurassic, and trees and flowers of modern aspect first in the Cretacic
Paleozoic	Triassic, Permic	Age of amphibians, with cycad plants common
	Carbonic	Great coal age, with large nonflowering plants
	Devonic	Age of fishes
	Siluric, Ordovicic, Cambric	Age of invertebrates, with some very simple fishes in the Siluric
Proterozoic, Archeozoic	Algonkic, Archean	Earliest known forms of life but records very imperfect

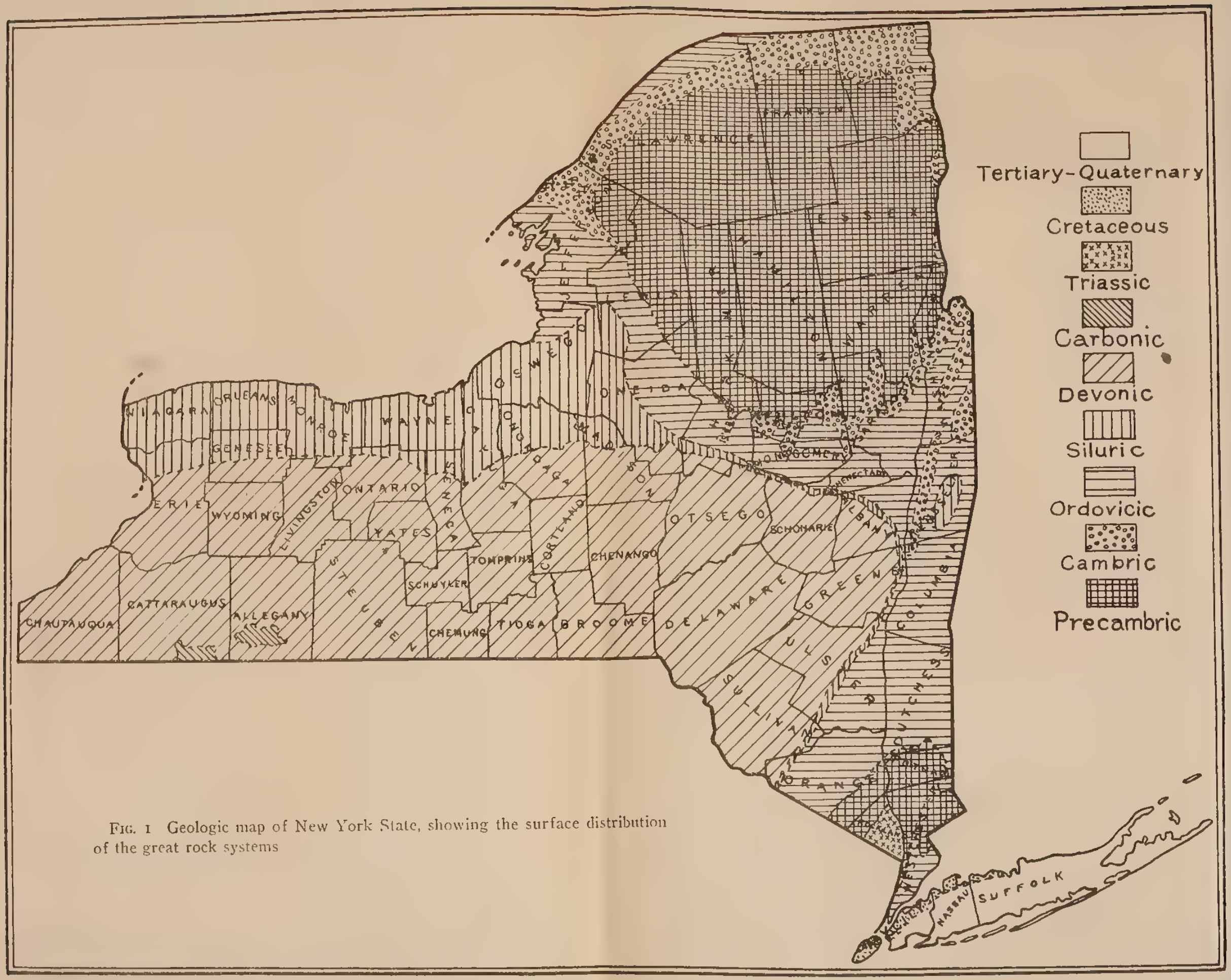


FIG. 1 Geologic map of New York State, showing the surface distribution of the great rock systems

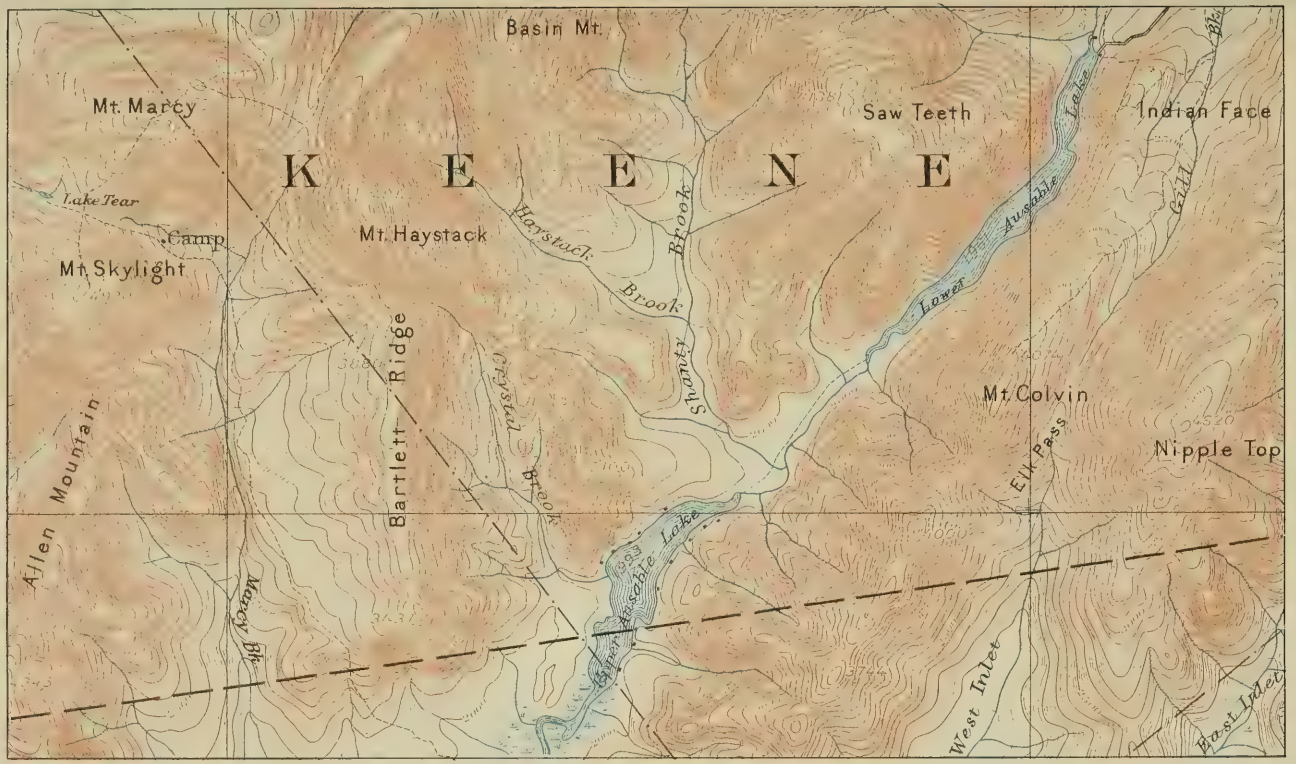
PERIODS, EPOCHS, AND ROCK FORMATIONS IN NEW YORK STATE

Quaternary	Recent clay beds, alluvium etc.	Surface deposits very common over the State
	Pleistocene. Glacial clay, sand, gravel, boulders etc.	
Tertiary	Pliocene, Miocene	Sands, clays, and gravels on Long Island
Cretacic	Monmouth, Matawan, Magothy, Raritan	Clay and sand on Long and Staten Islands
Jurassic	Absent (probably)	
Triassic	Newark sandstone and Palisade lava	Rockland county
Permic	Absent	
Carbonic	Olean conglomerate	Allegany and Cattaraugus counties
	Cattaraugus shale	
Devonic	Catskill and Chemung sandstones	Catskills and southwestern New York
	Portage shale and sandstones	South-central and western New York
	Genesee shale, Tully limestone	East-central to western New York
	Hamilton shale, Marcellus shale, Onondaga limestone, Oriskany sandstone, Helderberg limestone	East-central to western New York and eastern base of Catskill mountains
Siluric	Manlius limestone, Rondout waterlime, Cobleskill limestone, Salina shales, salt, waterlime and Shawangunk conglomerate	Eastern to western New York except Shawangunk in eastern New York only
	Lockport and Guelph dolomites, Rochester shale	Central to western New York
	Clinton shale, sandstone, limestone and iron ore	Central to western New York
	Medina and Oneida sandstone and conglomerate	Central to western New York

Ordovicic	Frankfort shale and sandstone	Central New York and western side of the Adirondacks
	Utica shale	
	Trenton limestone and shale	Around the Adirondacks and more or less in Hudson valley. Chazy absent from Mohawk valley
	Black river limestone	
	Chazy limestone	
	Beekmantown limestone	
Cambric	Little Falls dolomitic limestone	Around the Adirondacks and some in southeastern New York
	Potsdam sandstone and limestone	
	Acadian limestone	East of Hudson river from Washington county southward
	Georgian slate and quartzite	
Precambric	Igneous series — Anorthosite, granite, syenite, gabbro and diabase	Adirondacks and Hudson Highlands
	Grenville metamorphosed sediments	

Throughout this book the purpose is not merely to describe the physical features of the State, but rather constantly to emphasize the history or evolution of those features. The idea which I would now convey to the reader has been admirably expressed by Professor Davis in his "The Physical Geography of Southern New England": "Geography still retains too much of its old-fashioned, irrational methods: it has not kept pace with the advance made by geology. In spite of what the geologist has learned about the evolution of geographical forms, the geographer still too generally treats them empirically, and thus loses acquaintance with one of the most interesting phases of his subject. . . . It is often maintained that a devoted study of the facts themselves, without regard to their meaning or development, will suffice to place them clearly enough before the mind; but this view is contradicted both by general experience in many subjects where rational explanation has replaced empirical generalization, and by the special experience of geography as well. Left to itself as an empirical study, in which the development of land forms was hardly allowed to enter, it has languished for many years, until it became a subject for continual complaint. . . . Today it is only by those who fail to see the direc-

tion of geographical progress, and who are ignorant of the progress already gained, that objection is made against the effort to bring every geographical fact under the explanation of natural processes. No one of active mind can look across our upland and fail to gather increased pleasure and profit from understanding its history. No one who looks upon geography as the study of the earth in relation to man can contemplate the contrast between glaciated New England [or New York] and nonglaciated Carolina without inquiring into the meaning of the contrast: he might as well study the Sahara and the Sudan without asking the reason for the dryness of the one and the moisture of the other."



The highest and most rugged Adirondack topography, as represented by a portion of the Mt Marcy (U. S. G. S.) quadrangle. One of the northeast-southwest ridges so common in the eastern Adirondacks is shown just east of the lakes. The rocks are nearly all of plutonic igneous origin (anorthosite). Scale, about 1 mile to the inch. Those who are not familiar with the topographic map and its interpretation should refer to the explanation in the appendix.

A typical view in the midst of the Adirondacks. Looking across Long lake from Buck mountain, showing Mt Kempshall and Blueberry mountain. Note the flowing outlines of the topography.

From N. Y. State Mus. Bul. 115, pl. 15

General view in the Adirondacks looking northward across Lake Pleasant (Hamilton county). Note the flowing outlines of the topography.

Photo loaned by John A. Cole, Lake Pleasant, N. Y

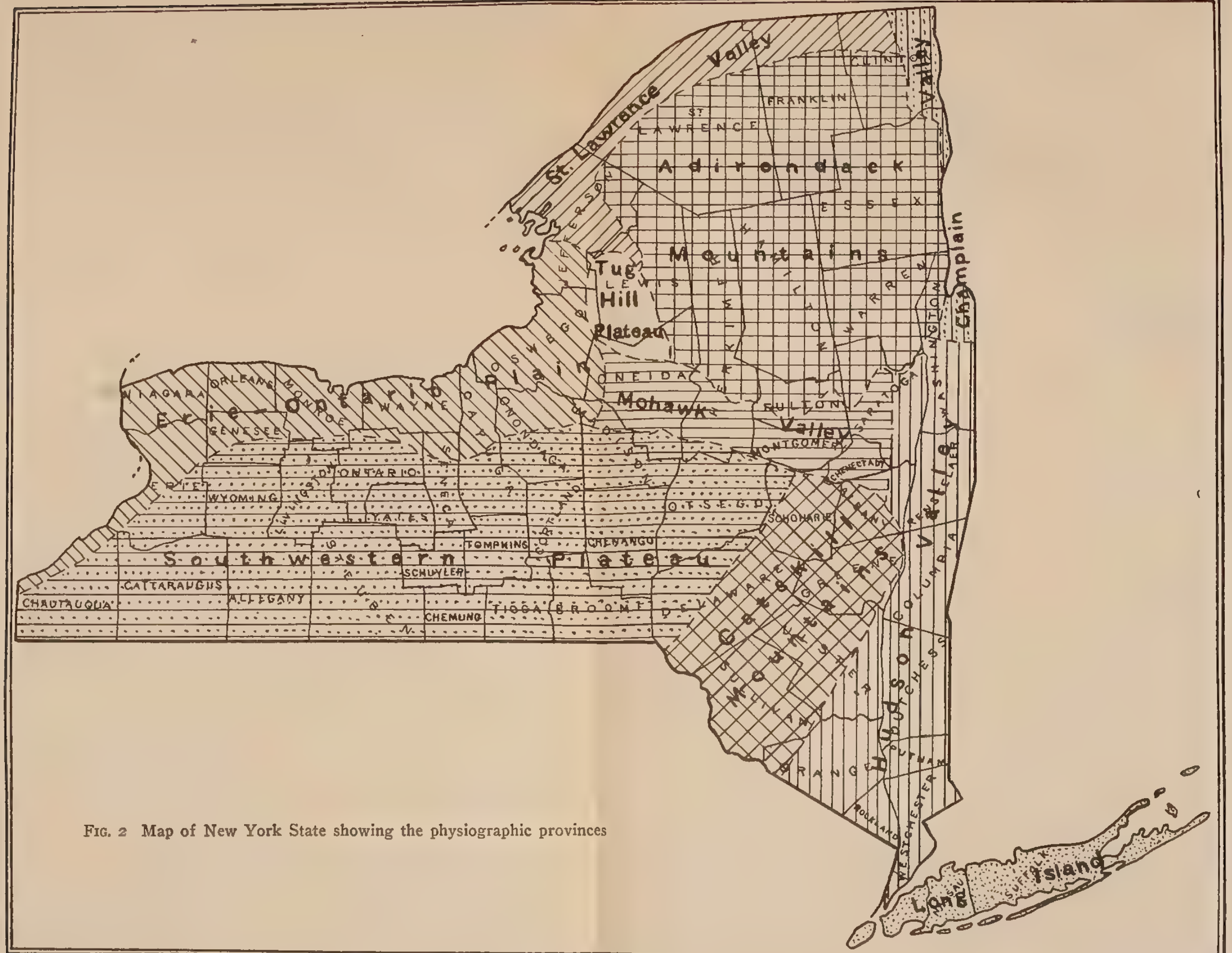


FIG. 2 Map of New York State showing the physiographic provinces

Chapter 2

PHYSIOGRAPHIC PROVINCES, STRUCTURE AND DRAINAGE

GENERAL STATEMENT

The area of this State is 49,170 square miles, including 1550 square miles of water. The range in altitude is from sea level to over 5000 feet, while the average elevation is about 900 feet. Mt Marcy (altitude 5344 feet) in Essex county is the highest mountain in the State.

For the sake of convenience in discussing the general physiography and structure, the writer has divided the State into certain well-defined physiographic provinces as shown on the accompanying map. Lest the sharp boundary lines convey a wrong impression, it should be stated that the provinces are, in reality, seldom sharply separated from each other (see figure 2).

ADIRONDACK MOUNTAIN PROVINCE

The Adirondack mountain province comprises fully one-fourth the area of the State and consists of a great, nearly circular mass of metamorphic and igneous rocks of very great age, that is, Prepaleozoic. This large mass of crystalline rocks is completely surrounded by the practically unaltered Cambric and Ordovicic rocks. The whole province is typically mountainous and heavily wooded, often being truly wilderness in character with very few roads or settlements other than summer resorts. Except along the immediate borders, the elevations range from 1000 to over 5000 feet. The greatest axis of elevation extends from southern Hamilton county (2000 feet) northeasterly well into Essex county where the highest mountains are grouped around Mt Marcy, and where the mountains commonly attain altitudes of from 3000 to 5000 feet (see plate 1). In the eastern and southeastern portions there is a well-defined tendency in the mountain masses to be arranged in long, nearly parallel ridges or "ranges" whose general trend is north-northeast to south-southwest. This structural feature is due to numerous faults or fractures in the earth's crust and will be explained on a later page. In the northern and western portions the mountains are very irregularly arranged. Viewed as a whole there are no high, sharp-topped peaks which stand out prominently above the general mountain level, and the flowing or rounded outline of topography is by far the most common (see plates 2 and 3). The very ancient Grenville rocks occur throughout the

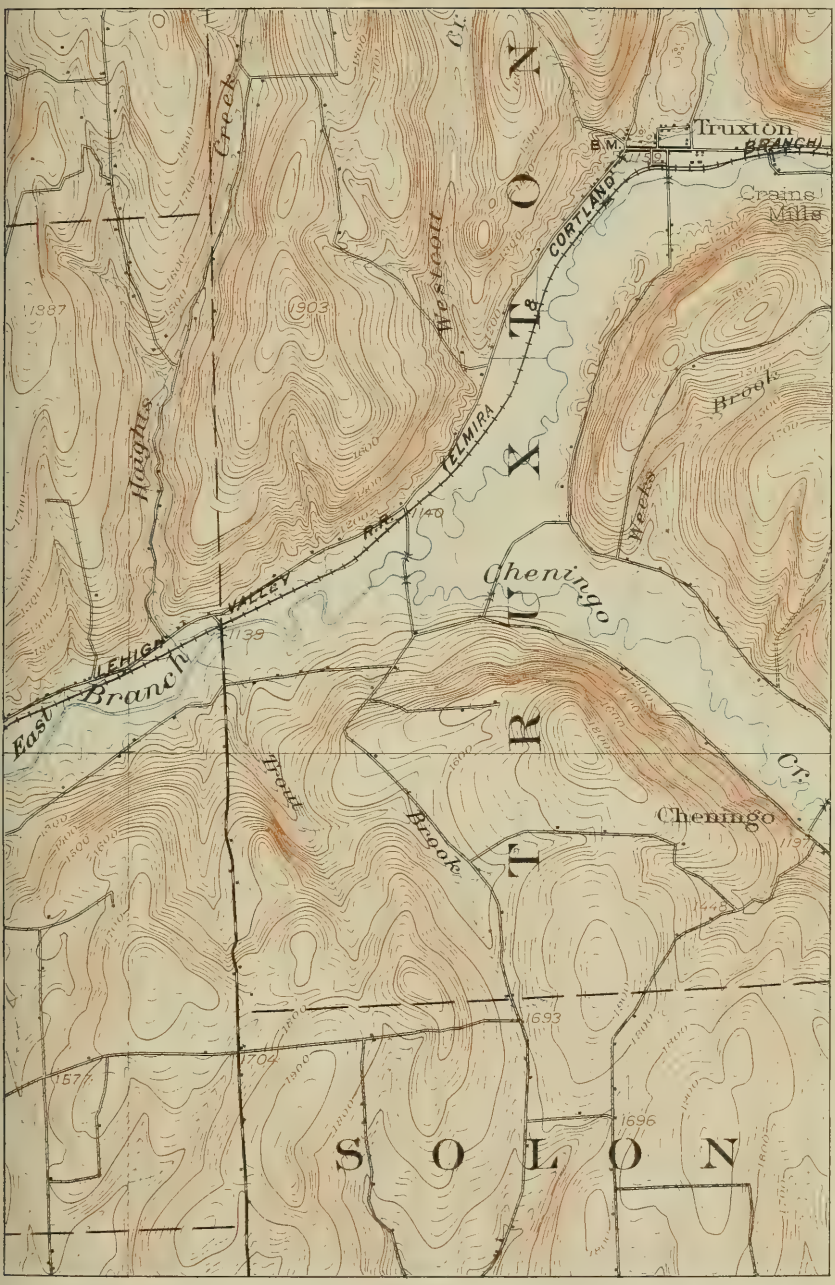
region, and great masses of igneous rocks have been forced through these. All these rocks have been subjected to tremendous earth pressure which has folded and thoroughly metamorphosed them.

SOUTHWESTERN PLATEAU PROVINCE

This, the largest clearly defined physiographic province, occupies nearly one-third of the area of the State. The rocks are all unaltered sediments of Devonic age, except a few small patches of Carbonic rocks in the southwest, and consist of shales, sandstones, and conglomerates. These formations exist as vast sheets or layers piled one upon another, with an aggregate thickness of several thousand feet (see figures 3 and 5). In marked contrast to the Adirondack province, the rock masses of this southwestern plateau are practically devoid of displacements, the only disturbance being a slight tilt (30 to 50 feet a mile) of all the strata to the south or southwest, associated with low northeast-southwest undulation.

Although this plateau is pretty well trenched or dissected by streams, it is nevertheless not a mountainous country, there being no high ranges or peaks standing out prominently. The elevation of the province varies from 500 to 600 feet on the northern side to over 2000 feet on the eastern and western sides. A notable feature is the distinct sagging of the plateau toward the middle portion. This sagged or depressed portion is occupied by the Finger Lakes, especially that portion filled by the south ends of Cayuga and Seneca lakes and the valleys which enter them from the south in the region of Chemung and Tioga counties. It is possible, by traveling along Seneca lake and thence southward to Elmira and the Chemung river, to pass entirely across the plateau province from north to south without attaining an altitude of much over 900 feet, which is on the divide between Watkins and Elmira.

Physiographically, the Plateau province is really but the northernmost extension of the great plateau which lies along the western base of the Appalachian mountains. On the east the province is bounded by the Catskill mountains which are in no sense sharply separated from the plateau itself. On the west and north the province is bounded by the Erie-Ontario plain and Mohawk valley provinces. The northern limit is pretty clearly marked by what is known as the "Helderberg escarpment" of Devonic limestone. This limestone, being of considerable thickness and more resistant than the neighboring formations, has generally stood out boldly against erosion, thus causing an abrupt change in relief. The escarpment is particularly prominent along the boundary of the



Typical southwestern plateau topography. Note the numerous irregular shaped hills, the high general level of the country and the deep broad-bottomed valleys occupied by the larger streams. The rocks are shales and sandstones of Devonic age. From Cortland (U. S. G. S.) quadrangle. Scale, about 1 mile to the inch.

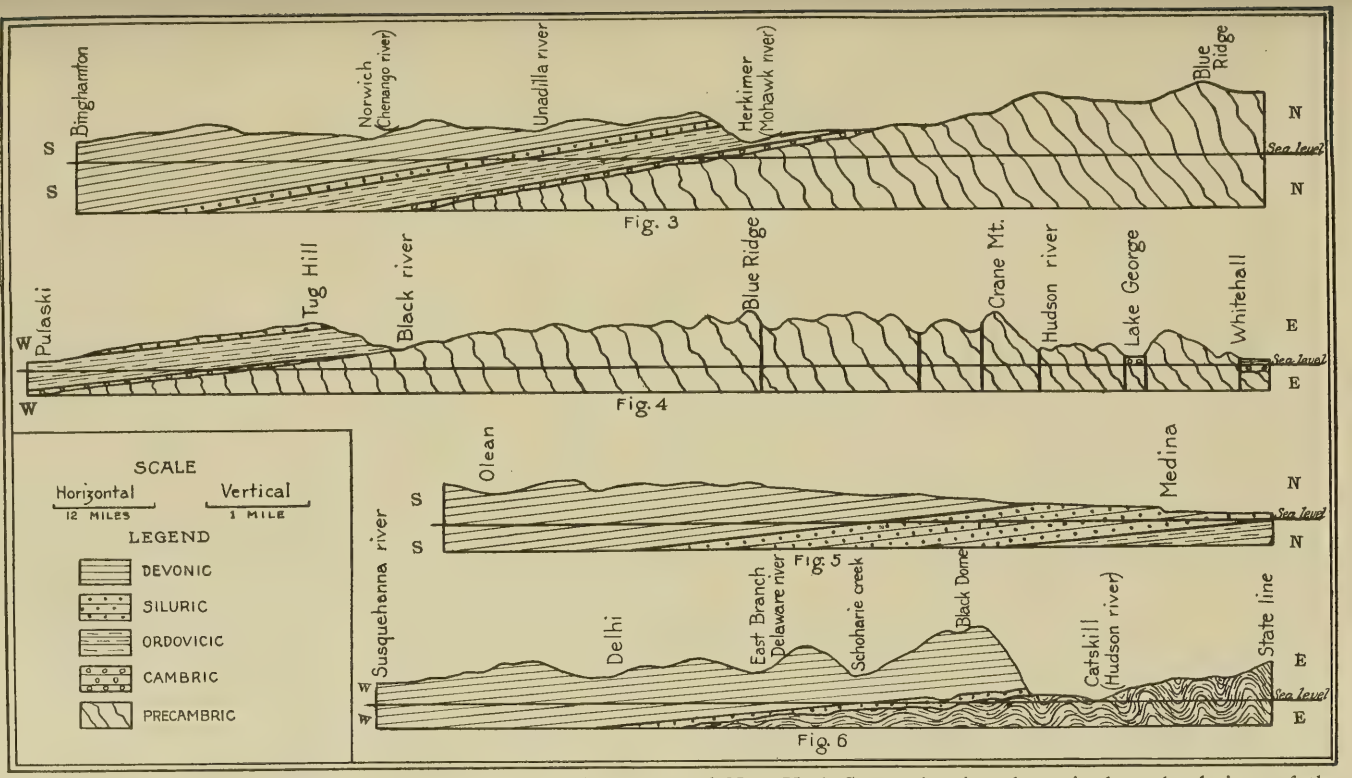


FIG. 3–6 Generalized structure sections through various parts of New York State, showing the attitude and relations of the great rock masses.

plateau and Mohawk valley provinces where the hard limestone lies at an altitude of more than 1000 feet, and directly overlies the soft shales of the valley whose altitude is only a few hundred feet.

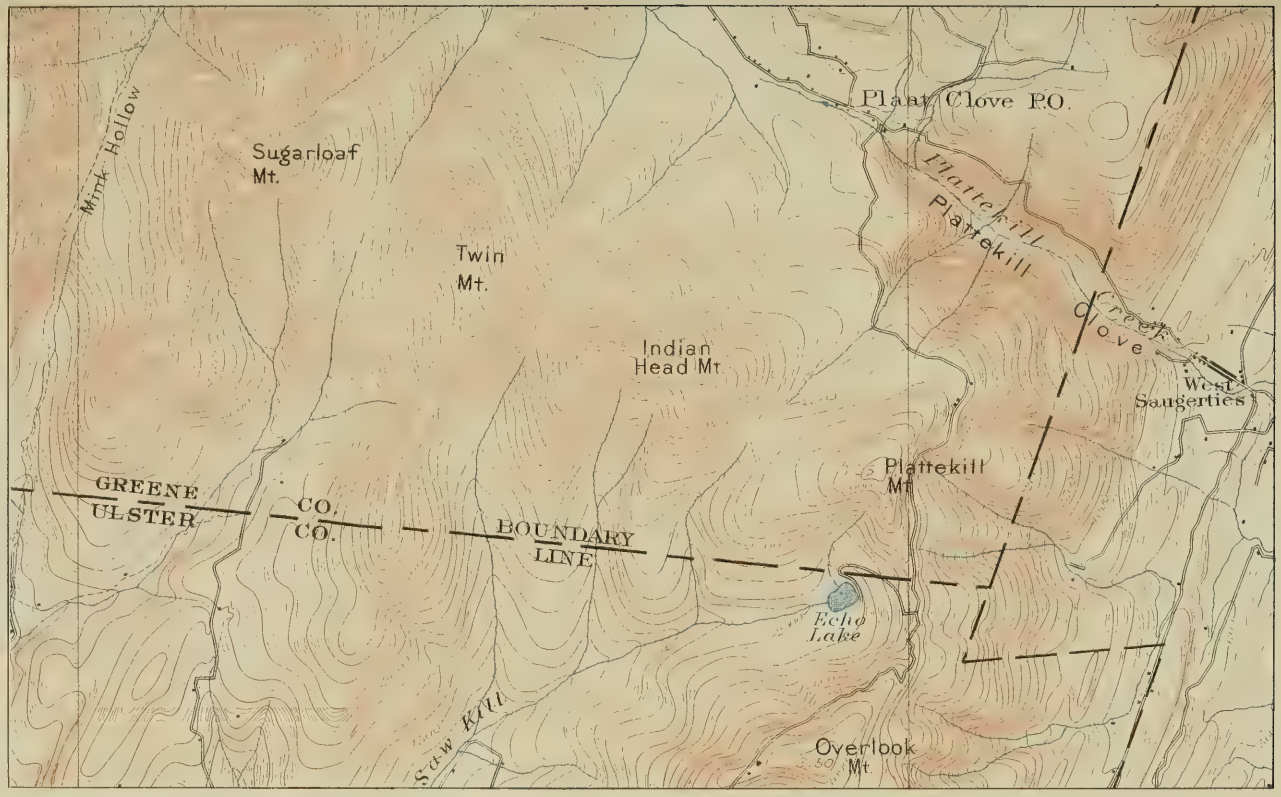
CATSKILL MOUNTAIN PROVINCE

This is the most rugged of all provinces in the State and, next to the Adirondacks, contains the greatest elevations. Slide mountain (4205 feet) is the highest, while a number of points range from 3500 to over 4000 feet in altitude.

The rocks are all of Devonic age and consist almost entirely of sandstones and conglomerates. Except for a slight westward undulation, these rocks are arranged in practically horizontal layers and show an aggregate thickness of several thousand feet (see figure 6). Lying under these Devonic rocks and outcropping at the very base of the mountains on the north and east, are various formations of Siluric age.

The term "mountains" as applied to the Catskills requires some explanation. The more typical mountains of the world have been formed by folding or faulting of the strata, or by igneous activity, or by two or all of these causes combined. For example, in the development of the Appalachians both folding and faulting have played prominent parts, while in mountains like the Sierras or Adirondacks, folding, faulting, and igneous action have all been important. The Catskills, however, in which these typical mountain phenomena are wholly lacking, are to be properly placed in the category of what we may call "erosion mountains." Mountains of the pure erosion type are due to an uplift of land high above sea level, followed by deep dissection of the elevated mass by the action of streams. The Catskills are only an easterly extension of the plateau province where the rocks are more resistant and perhaps the elevation of the region was greater, so that the streams were able to cut deeper trenches while the harder rocks of the divides have so far prevented a general wearing down of the region. The Catskills furnish a remarkable example of a high plateau deeply dissected by numerous streams. The whole topography is very rugged, all being much like that of the highest portion of the Adirondacks around Mount Marcy (compare plates 2 and 5). The Catskills, however, lacking the proper structural features, show practically no tendency to parallel arrangement of ridges or mountains as is so common in the Adirondacks.

On the south the Catskill province almost grades into the folded region of the Appalachians, while on the west it gradually merges into the southwestern plateau. On the north the Helderberg



Map of part of the Catskill province showing the high, rugged character of the mountains and the remarkably steep, high eastern front of the province overlooking the great Hudson valley. From the Kaaterskill (U. S. G. S.) quadrangle. Scale, about 1 mile to the inch.

The pass between Hunter and Plateau mountains in the Catskills. This is a fine example of the deep, steep-sided, V-shaped valleys so characteristic of this province.

From Annual Rep't N. Y. State Geol., 1897, pl. 20, facing p. 282

escarpment, standing out abruptly and to a great height, forms a sharp boundary. On the eastern side the Catskills present a very steep, high front facing the Hudson valley. This steep front rises about 3000 feet and consists of hard Devonic sandstones and conglomerates overlying the Siluric strata (see figure 6).

MOHAWK VALLEY PROVINCE

The Mohawk valley province, though comparatively small, is of great importance because it so clearly separates the Adirondack highlands on the north from the highlands of the Catskills and southwestern plateau provinces on the south. In fact it should be noted that the Mohawk valley is by far the lowest passageway across the mountains between the St Lawrence river and the southern end of the Appalachian range. This low pass is one of the great eastern "gateways" which, with the St Lawrence, have afforded the easiest means of communication between the Atlantic seaboard and the region west of the Appalachian mountains.

The comparatively narrow inner valley through which the river now flows is often erroneously called the Mohawk valley, but in reality the whole depression, from 10 to 30 miles wide and fully 1000 feet deep, between the northern and southern highlands of the State, should be called the Mohawk valley. At Little Falls the inner valley narrows to a gorge several hundred feet deep, where the river has cut its way through a preglacial divide (see plate 7 and figure 7). Had it not been for the recent cutting of this gorge (see explanation accompanying plate 44 in chapter 6) through the barrier at Little Falls, the Mohawk valley would never have been so important as a great gateway between the Atlantic coast and the west. Today the four tracks of the New York Central Railroad, two tracks of the West Shore Railroad, the Erie canal (now being enlarged to the Barge canal), an important highway, many telegraph and telephone wires, and the Mohawk river all pass through this narrow gorge and within a few hundred feet of sea level. Eastward and westward from Little Falls, the inner valley is generally fairly wide and open (see plate 7). At Little Falls the Mohawk river is less than 400 feet above sea level and even at Rome, in the western part of the province, the river shows an altitude of only 420 feet.

The principal rocks of the province are shales, sandstones and limestones of Cambric and Ordovicic ages; of these the soft, black shales of Trenton, Utica, and Frankfort ages are in greatest abundance. The valley owes its existence largely to the presence of this belt of soft shales lying between the hard crystalline rocks

of the Adirondacks on the north and the comparatively hard limestones immediately southward. The work of erosion has made rapid progress in this belt of weak rocks, and at two places, Little

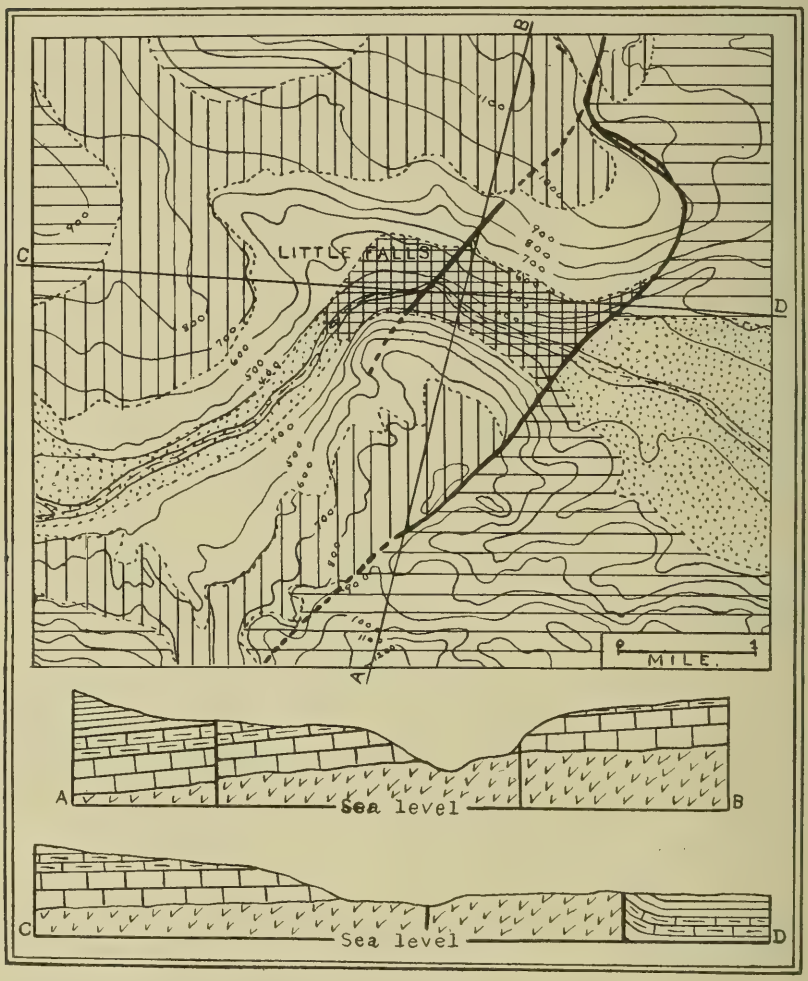
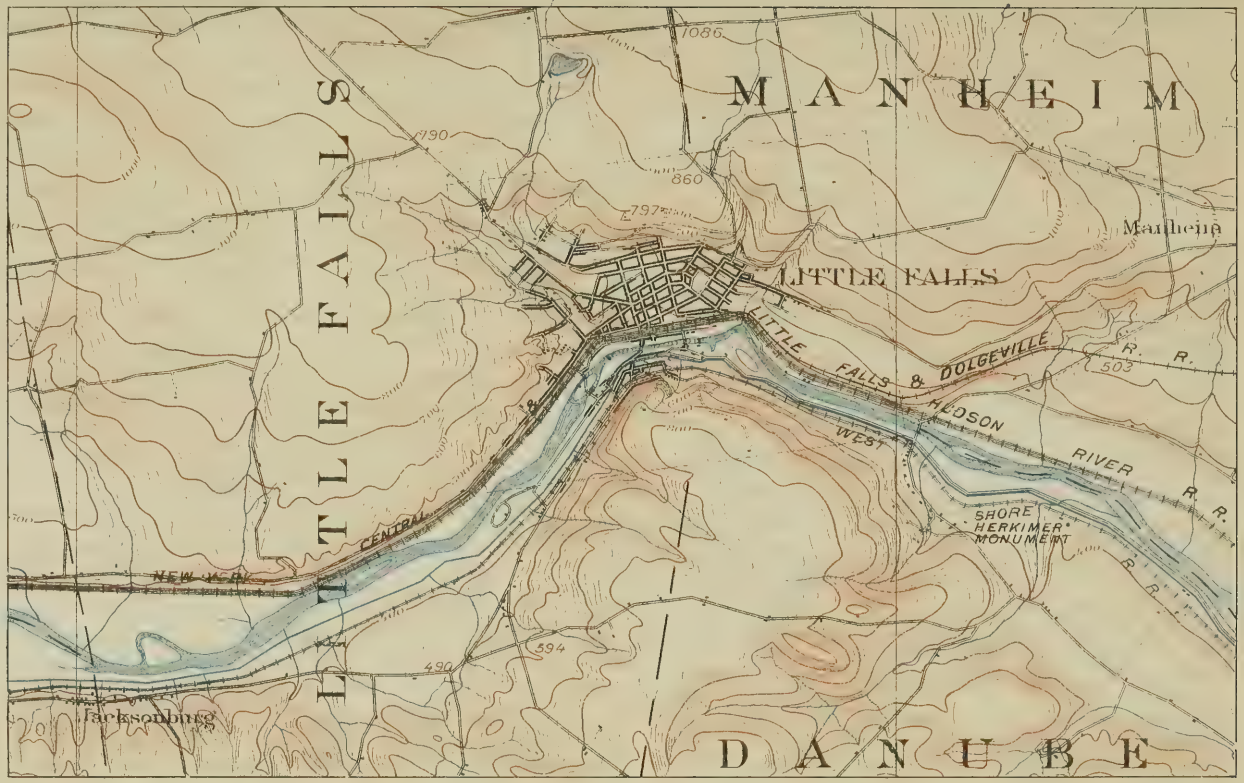


FIG. 7 Geologic and topographic sketch map and structure sections of the vicinity of Little Falls. Crosslined area at bottom of gorge = Precambric rock (syenite); blank areas = Little Falls (Cambric) dolomite; vertical line areas = Trenton (Ordovicic) limestone and shale; horizontal lined areas = Utica (Ordovicic) shale; dotted areas = Quaternary sand and gravel. Heavy black lines are faults. The structure sections show the condition of things along the lines AB and CD. In the sections the vertical scale is four times exaggerated.

Based upon map by H. P. CUSHING



Topographic map showing the deep, narrow gorge of the Mohawk river at Little Falls. The walls of the gorge rise fully 500 feet above the river which is less than 400 feet above sea level. The gorge is postglacial in origin and before the great ice age it was replaced by an important divide with one stream (Mohawk river) flowing eastward and another stream (Rome river) flowing westward. Part of Little Falls (U. S. G. S.) quadrangle. Scale, about 1 mile to the inch.

Falls and "The Noses" (Yosts), the river has cut down to the Precambric (Adirondack) rock. In general, the rock formations of the province tilt slightly southwestward and show folding only on a very small scale. From Little Falls eastward, however, the strata are greatly disturbed by numerous nearly north-south faults which are often of considerable magnitude (see figure 25).

ERIE-ONTARIO PLAINS PROVINCE

On the extreme western side of the State, and lying between Lake Erie and the Southwestern plateau, there is a strip of land only a few miles wide which may be called the Erie plain. This plain is of very low relief and slopes from an altitude of from 800 to 900 feet down to the level of Lake Erie, whose altitude is 573 feet. Where the Erie plain joins the Southwestern plateau there is a very decided change of slope. The rocks underlying this plain are dark shales of Devonic age and show the usual slight southwestward tilt (see plate 31).

The Ontario plain is much larger and lies between Lake Ontario and the Southwestern plateau, the southern boundary being marked by the "Helderberg escarpment." This large province slopes gradually to the shores of Lake Ontario and is remarkably free from relief features of any considerable magnitude. One that deserves mention is the presence of many hundreds of low, glacial knobs (drumlins) which are thickly scattered over the whole plain between Rochester and Syracuse (see plate 42). Another feature which serves to break the monotony of the plain on the west is the low but distinct escarpment of Niagara limestone, which extends from Lewiston eastward to beyond Lockport. On the east the Ontario plain gradually merges into the Mohawk valley province on the one hand, and on the other hand comes against the western foot of the highlands of the Tug Hill province.

The rocks underlying the Ontario plain are chiefly sandstones, limestones and shales of Siluric age, which show the usual tilt toward the south. At the extreme northeast, limestone and shale of Ordovicic age are present and these show a slight westward tilt.

TUG HILL PROVINCE

The Tug Hill region is worthy of recognition as a distinct physiographic province because we have here a highland mass of considerable extent entirely separated from the neighboring provinces. The highest point, six miles west-northwest of Lyons Falls, Lewis

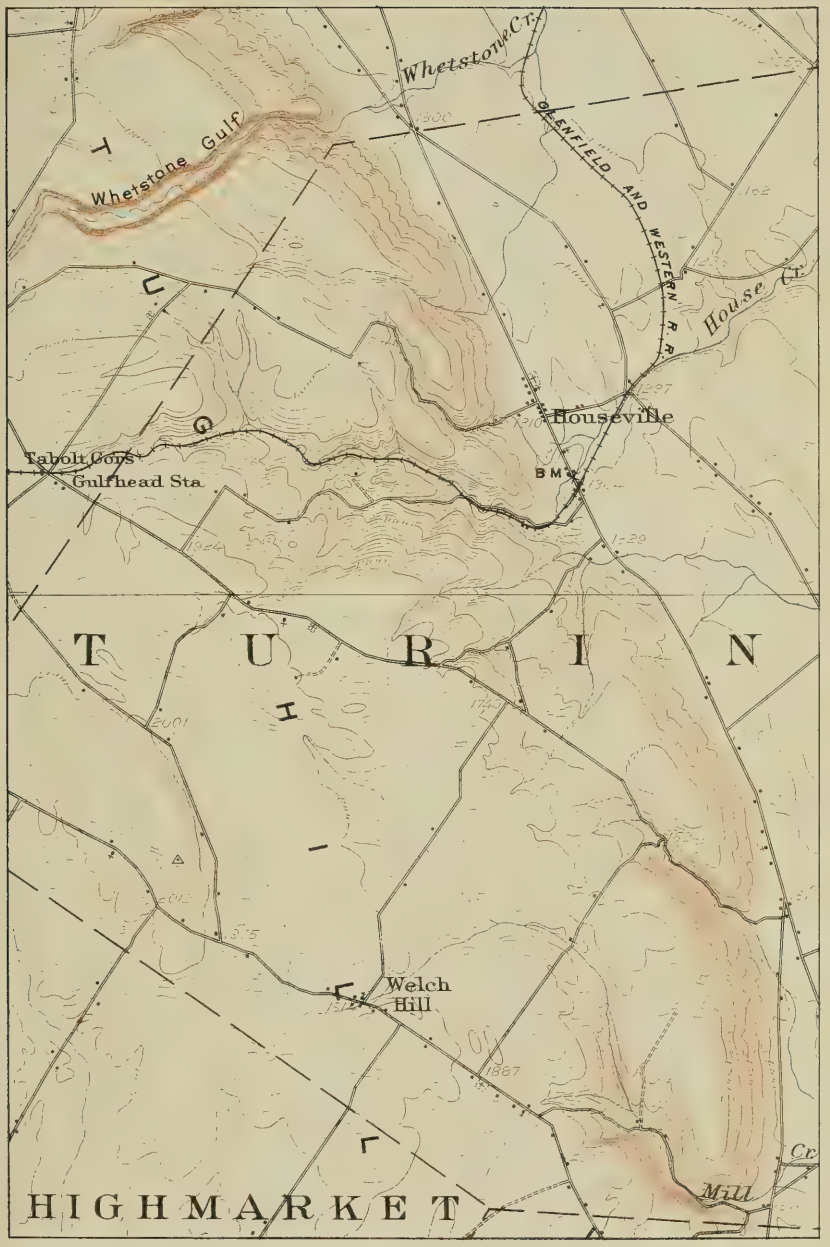
county, reaches an altitude of nearly 2100 feet, while the central portion of the province, covering many square miles, is remarkably flat and swampy with the general level above 1800 feet of elevation. On a smaller scale, this is as truly a plateau as the great Southwestern plateau already described and, interesting to note, this Tug Hill plateau is merely an erosion remnant of the great upraised Cretacic peneplain (see chapter 5) which formerly included all of New York State.

On the south and west this province slopes rapidly downward to the lowlands of the Mohawk valley and Ontario plain provinces, while on the east and north the Black river valley sharply separates this province from the Adirondack and St Lawrence Valley provinces. The rapid descent into the Black river valley bottom is everywhere 1000 feet or more over a series of high, steep terrace fronts (see plate 8). In passing, it should be stated that, though seldom recognized, this Black river depression takes rank as one of the few greatest valleys within the borders of the State.

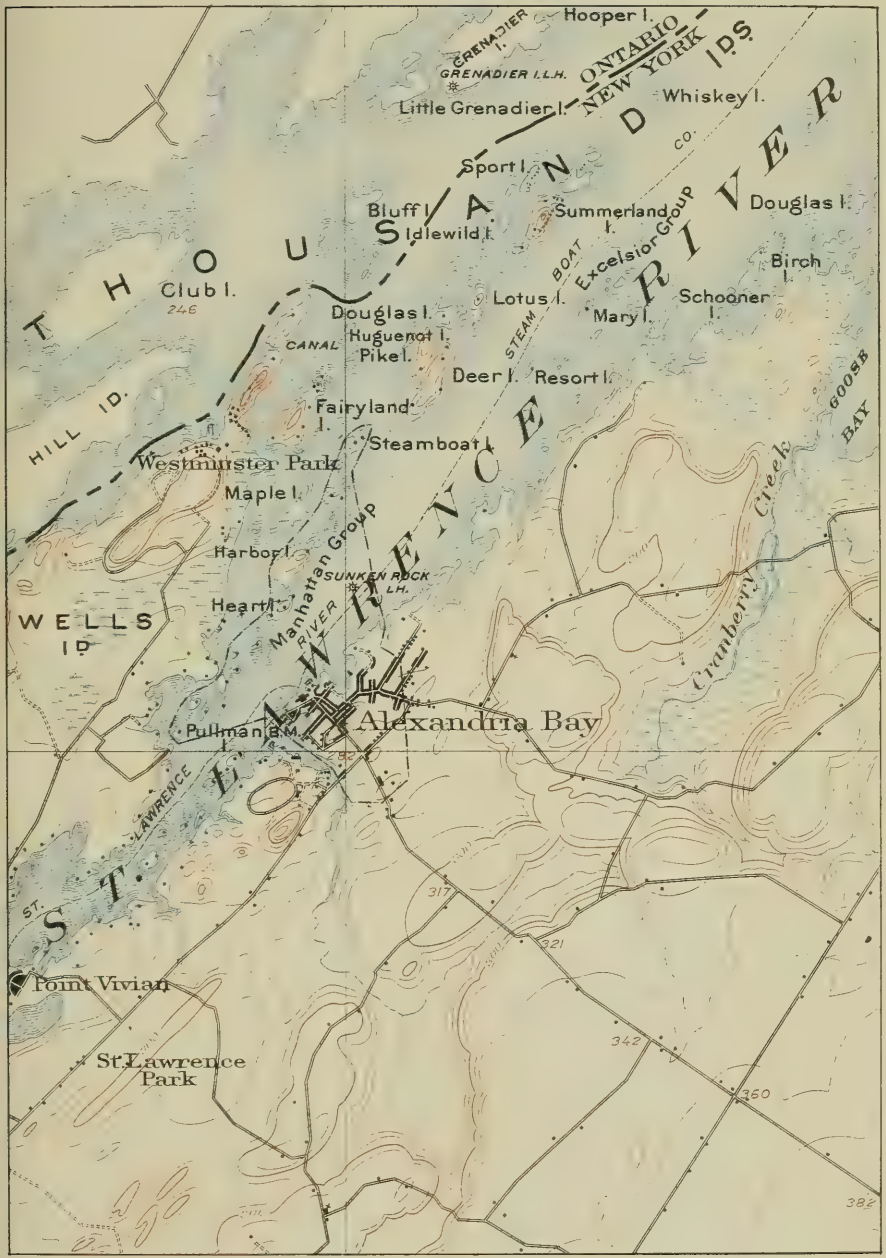
Near Boonville, and at an elevation of about 1100 feet, occurs the division of drainage between the Mohawk and Black rivers, and this divide forms the highest land connecting the Tug Hill and Adirondack provinces. But in spite of this partial connection and the close proximity of the province to the Adirondacks, the rock formations and structure are wholly different from those of the Adirondacks while they greatly resemble those of the Southwestern plateau. The rocks are all of lower Paleozoic (chiefly Ordovicic) age, with several hundred feet of limestone at the base followed by about a thousand feet of shales, the whole being capped by a resistant sandstone of Siluric age. These strata tilt slightly westward but they have never been disturbed by folding, faulting or igneous activity (see figure 35).

ST LAWRENCE VALLEY PROVINCE

The St Lawrence valley, lying along the northern boundary of the State, is a great, open depression of comparatively simple structure and near sea level. Where the river leaves Lake Ontario, the elevation is only 247 feet, while points with elevations more than a few hundred feet seldom occur within the province. As shown on the accompanying map (plate 9), low hills are common over the valley floor. The Thousand Islands form a remarkable physiographic feature of the province, where the wide, slow-moving St Lawrence river does not occupy any very distinct channel, but



A portion of the Port Leyden (U. S. G. S.) quadrangle, illustrating the topography of the Tug hill plateau. Note the high, general plateau level at from 1800 to 2000 feet above sea level and the abrupt termination of this plateau on the east side. Whetstone gulf is a fine example of numerous gorges cut through the steep plateau front. Scale, about 1 mile to the inch.



The Thousand Islands region in the vicinity of Alexandria Bay. The broad river, dotted with islands, does not here occupy a distinct stream channel in the usual sense of the term. A removal of the water would show that the topography of the river bottom is in no way essentially different from that of the country just south of Alexandria Bay. From Alexandria Bay (U. S. G. S.) quadrangle. Scale, about 1 mile to the inch.

rather flows across a broad, low, hilly region of very moderate relief thus allowing the low rocky hills to stand out as islands.

The rocks are chiefly sandstones and limestones of Cambric and Ordovicic ages, though, in the vicinity of the Thousand Islands numerous patches of the underlying Precambric (Adirondack) rocks are exposed as on many of the islands themselves. Folds, faults and igneous rock are not present except in the Precambric rocks, and the strata may be regarded as a comparatively thin mantle of nearly horizontal layers overlying the Precambric rocks.

CHAMPLAIN VALLEY PROVINCE

The Champlain valley bounds the Adirondacks on the east and the province should be regarded as a great depression separating the Adirondacks on the west from the Green mountains on the east. Much of the valley bottom is filled by the waters of Lake Champlain (elevation 101 feet). Along the western shores of the lake the topography is characteristically hilly, though seldom above 500 feet in elevation. The transition to the higher and rugged Adirondacks is generally rapid.

The rocks occupying the valley bottom are sandstones, limestones and shales of Cambric and Ordovicic ages. These formations are much disturbed by numerous faults, often of considerable magnitude, and in fact there is good reason to think that the whole Champlain valley is of the nature of a great fault-trough or depression.

HUDSON VALLEY PROVINCE

General description. Looked upon in a broad way, the Hudson valley province is a depression lying between the western highlands of New England and the eastern highlands of New York. Well toward the south the true valley feature is somewhat interfered with by the presence of such elevated masses as Shawangunk mountain and the Highlands-of-the-Hudson. A very detailed classification of topographic features would call for four or five provinces instead of the one here called the Hudson valley province. Since even this southern part, however, is lowland compared with the Catskill mountains immediately westward and since the rock structures are so similar and characteristic throughout the region, though the kinds of rocks vary considerably, it seems best for our purpose to treat all together as the Hudson valley province and then very briefly describe each of the minor subdivisions of the province.

The foundation rocks of the whole province comprise various formations of Precambric, Cambric, and Ordovicic ages, while in a few places mere surface layers of Siluric, Devonic, and Mesozoic strata occur (see geologic map, figure 1). All the rocks, except these few younger surface layers, are highly folded, which constitutes the most characteristic structural feature of the whole province. In fact, as is hereafter shown (see chapter 4), there are here exposed the roots or remnants of a portion of the great and very ancient Taconic mountain range which at one time occupied this

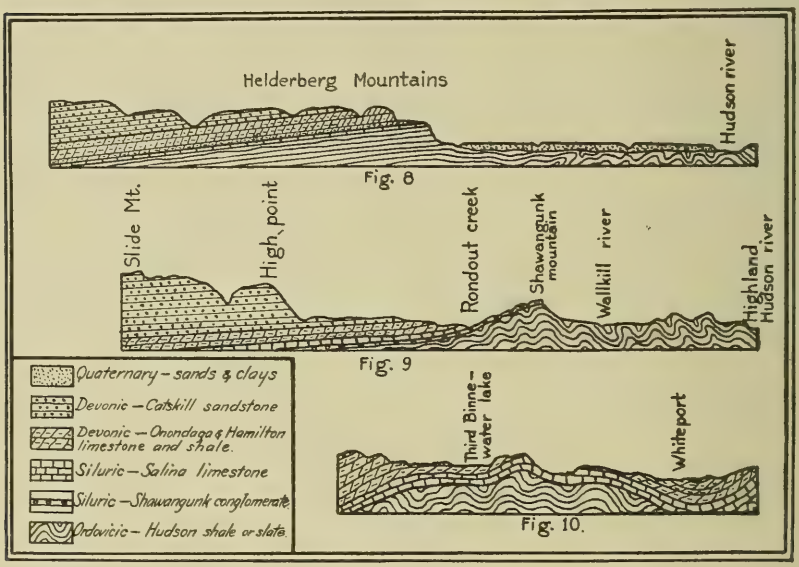


FIG. 8 Section from southwest to northeast through Albany county and showing the Taconic folds near the Hudson.

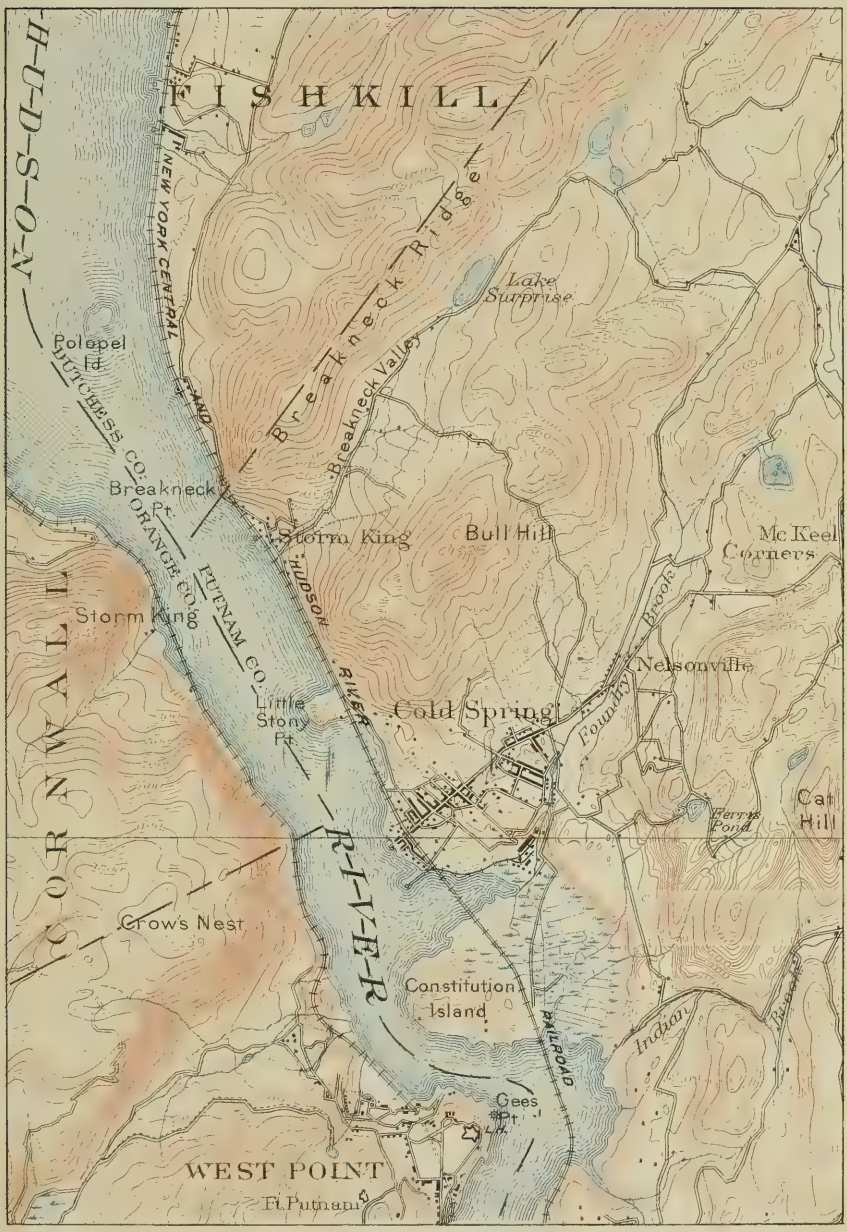
FIG. 9 Section from northwest to southeast across Ulster county and passing through Slide mountain and Highland village. Taconic and Appalachian folds both sides, as well as the structure of Shawangunk mountain.

FIG. 10 More detailed section through cement district at Whiteport, Ulster county. Both Taconic and Appalachian folds are well exhibited.

These sections all modified after Darton, N. Y. State Mus. Rep't 47, 1894, pp. 430, 490, 532

region. Thus from the geologic standpoint, the term Taconic province would be appropriate. All along the border of the province, as well as throughout the Hudson Highlands, the rocks are rather severely metamorphosed.

Highlands-of-the-Hudson. The Hudson Highlands extend across the Hudson valley in a northeast-southwest direction, and cover southern Orange county and northern Rockland county, and the region from southern Dutchess southward across Putnam



A portion of the West Point (U. S. G. S.) contour map, illustrating the topography of the Highlands of the Hudson. The river here flows through a deep, narrow gorge which has been cut through the northeast-southwest ridges of very hard Precambric rock. The sides of the gorge rise abruptly from the river to heights of 1200 or 1400 feet, while the rock bottom of the gorge is hundreds of feet below the river level. Scale, about 1 mile to the inch.

Looking north up the Hudson where the river flows through a deep narrow gorge in the hard granitic (Precambric) rocks of the Highlands. The mountain on the left is Crow's Nest and the nearer one on the right is Bull hill. Each of these mountains rises to more than 1400 feet above the river while the rock bottom of the river is buried some 600 to 800 feet. Compare with plate 20.

From N. Y. State Mus. Bul. 146 p,l. 16

and into Westchester county. The relief is rather rugged with the higher points commonly reaching altitudes of over 1000 feet. The rocks are chiefly granites and gneisses of Precambric age, and are in most ways much like those of the Adirondacks.

Region north of the Highlands. North of the Highlands the rocks are in the main highly metamorphosed shales, sandstones and limestones, and the relief is generally low except along the eastern border where it is almost mountainous. A characteristic feature along this eastern side is the presence of long, fairly high, nearly north-south ridges separated by comparatively narrow valleys.

Shawangunk mountain. Lying close to the southeastern border of the Catskills and extending northeastward from the State line in Orange county well into Ulster county, is a distinct mountain ridge known as Shawangunk mountain. This long, narrow mountain rises 1000 feet or more above the surrounding country, and with the deep narrow Rondout valley immediately on its west side and the broad, open Wallkill valley on the east, it is truly a remarkable topographic form. The capping of very hard Siluric conglomerate upon the soft Ordovicic shales has caused the ridge to stand out so boldly against erosion (see figure 9 and plate 28).

Region south of the Highlands. Southern Rockland county is covered by Mesozoic (Triassic) sandstone. This rock is not folded but contains within its mass great sheets of lava which outcrop to form the Palisades along and west of the Hudson (see figure 20).

In southern Westchester county and in New York county there are highly folded and metamorphosed Precambric and Ordovicic rocks, and the country is typically hilly.

LONG ISLAND PROVINCE

This province, including Staten Island, is really a part of the broad Atlantic coastal plain and is therefore practically devoid of any hard rock formations at the surface. Except for a few exposures of Cretacic sands and gravels along the northern border, the whole province is made up of glacial sands and gravels. From the standpoint of surface relief the province is clearly divisible into two parts, a northern and a southern, which are sharply separated from each other (see plate 12). The northern part is characteristically hilly, the hills being of glacial (morainic) origin. The maximum elevation is less than 400 feet, while in general the hills are from 100 to 200 feet high. This line of hills ends abruptly about midway of the island (north-south) and the southern part of the province is a sand plain of remarkable smoothness with a gentle slope toward the ocean.

DRAINAGE

Considered as a great watershed, New York State takes rank as one of the most noteworthy in the United States. The waters of the State, except for a little in the southeast, enter the sea at five widely separated places, namely, Gulf of St Lawrence, New York bay, Delaware bay, Chesapeake bay, and the Gulf of Mexico, through the five well-known rivers, namely, St Lawrence, Hudson, Delaware, Susquehanna, and Mississippi (through the Allegheny and Ohio rivers).

Mohawk-Hudson basin. The principal stream of this, the largest drainage basin of the State, is the Hudson river which is especially noteworthy in two ways, first because it is by far the largest stream whose course is wholly within the borders of the State, and second because soon after emerging from the Adirondacks (near Glens Falls), its course, for nearly 200 miles to its mouth, is remarkably straight in spite of the fact that it traverses the principal structural lines of a highly folded and disturbed region. Its apparently anomalous, deep, narrow, granite-walled channel across the Highlands of the Hudson (see plate 10) will be explained in chapter 6. The chief tributary and essential part of the Hudson, the Mohawk river, has its headwaters in the very center of the State and reaches the Hudson after flowing eastward for more than 100 miles.

The drainage of the southern Adirondacks, even as far north as Mount Marcy, and of the eastern Catskills passes into the Hudson river. Except for very minor contributions from the edge of New England and New Jersey, the whole river system derives its water from within the boundaries of the State.

St Lawrence basin. This drainage basin comprises all the northwestern Adirondacks and reaches well into the heart of the mountains. All the larger streams, which are of very moderate size, flow northwestward in remarkably parallel courses until, emerging upon the floor of the St Lawrence valley, they swing around to northeasterly courses and generally flow for a good many miles parallel to the great river itself before entering it. This latter phenomenon is, no doubt, to be explained on the basis of topographic changes due to the great Ice age. The largest and longest stream in the basin is the Raquette river which, after a devious course of more than 100 miles, including passage through two or three large lakes, enters the St Lawrence at the northern State boundary.

Ontario basin. All the streams of this basin enter Lake Ontario and pursue courses that, if continued, would tend to converge at a

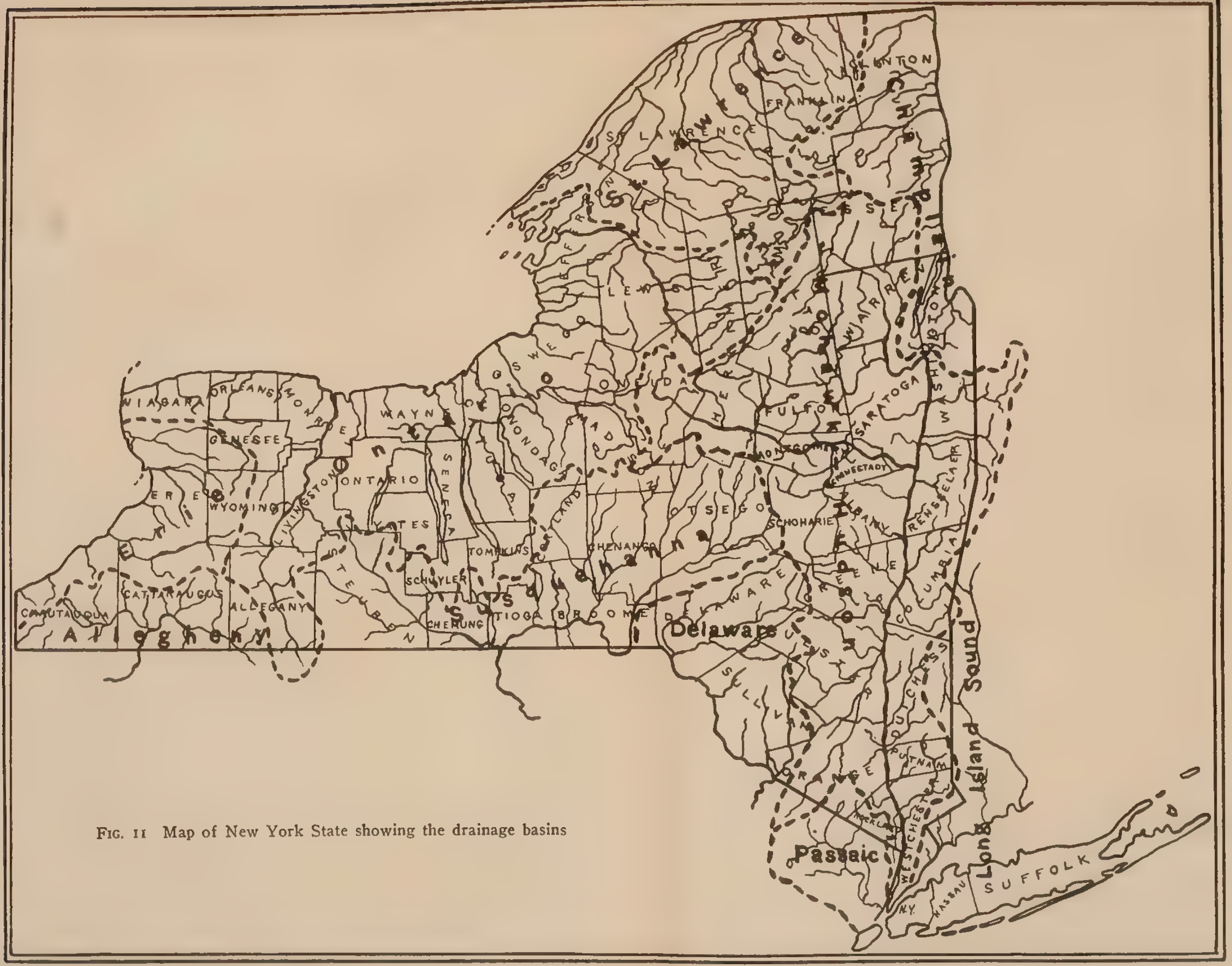


FIG. 11 Map of New York State showing the drainage basins

A portion of the Islip (U. S. G. S.) quadrangle showing typical Long Island topography. Note the distinct hills (of glacial morainic origin) on the north, the perfect plain only very slightly stream-dissected and with very gentle seaward slope, and the long beach (built by wave action) inclosing the shallow bay with its many swampy islands. Scale, about 2 miles to the inch.

point in the lake basin. Thus the streams in the western portion of this drainage basin flow north to northeastward, northward in the middle portion, and westward to northwestward in the eastern portion. Three rivers should be mentioned: the Genesee, with its source in the highlands of Pennsylvania, flows northward across the entire southwestern plateau; the Oswego, toward the middle of the basin, takes one arm (Seneca river) from the west to drain the large Finger lakes and another arm from the east to drain Oneida lake and part of the Tug Hill plateau; Black river drains the extreme eastern portion of the basin, and a number of prominent tributaries flow southwestward from well within the Adirondacks to join the main stream in the great Black river valley.

Susquehanna basin. All the waters of the Susquehanna river are derived from the Southwestern plateau. The main stream (within New York) flows southwestward and together with its numerous large tributaries drains much of the eastern portion of the plateau region, especially in Otsego county. A number of the tributaries rise on the very crest of the Helderberg escarpment and within a few miles of the Mohawk river. The Mohawk river is fully a thousand feet below the crest of the escarpment, and its course is at right angles to that of Susquehanna tributaries.

The Chemung is the principal tributary from the northwest and drains a good portion of the south-central plateau.

Other drainage basins. The Champlain basin comprises the eastern border of the Adirondacks, including some of the highest and most rugged of those mountains. Nearly all the streams are short and most of them descend eastward very rapidly into Lake Champlain.

The Delaware, by means of its upper waters, drains the western and southern Catskills and the main stream, after flowing southeastward along the State line between New York and Pennsylvania, from Delaware county to Orange county, suddenly swings southwestward to pass through the famous Delaware water gap in the Kitatinny range.

The Allegheny river sends out a number of small branching arms to drain the extreme southwestern portion of the Southwestern plateau. Chautauqua lake (elevation 1338 feet) which lies at the very western edge of the plateau and close to Lake Erie, has its outlet into the Allegheny.

The Erie basin contains no river of much consequence, the small streams all flowing westward or northwestward across the narrow Erie plain and into Lake Erie or the Niagara river. Nearly all

these streams rise along the western edge of the Southwestern plateau.

In quantity very little of the water of the State enters the Long Island sound basin, a few small streams north of the sound together with the numerous but very small streams of Long Island comprising the whole supply.

The Passaic basin is mostly confined to New Jersey, with a few small streams having sources in Rockland and Orange counties.

Chapter 3

PRECAMBRIC HISTORY

THE GRENVILLE FORMATION

In the Adirondack mountains, and also probably in the Highlands-of-the-Hudson, we have the earliest known records of the physical history of New York State. These records are written in a series of rocks named the Grenville, so called from a town in Canada where the rocks were first well known. The Grenville is of interest, not only because it is the most ancient rock formation so far discovered in New York, but also because it takes rank among the very oldest rock formations of the earth.

Until about fifteen or twenty years ago the real significance of the Grenville and its closely associated rocks in the Adirondacks was not recognized, but now many of the leading events of that very early history are established. As in human history, so in earth history, the earliest records are the most obscure and difficult to read and, in the one as in the other, it is easy to pass from conclusions properly based upon facts to mere speculations. Many problems regarding the Precambric history of our State yet remain to be solved, but in these pages it is rather the purpose to describe only those historical events which have been well established.

The Grenville consists of a great series of marine water-laid rocks which are clearly older than the Paleozoic because these latter rest upon the Grenville in many places. As will be shown below, the Grenville strata have been so profoundly changed from their original condition that certain of the highly sedimentary features have been obliterated. Thus the absence of water-worn particles and fossil shells, both of which are so characteristic of sedimentary deposits, is due to complete crystallization (metamorphism) of the Grenville strata since their formation. Nevertheless we have certain proofs of the sedimentary origin of the Grenville. The fact that these rocks commonly occur in alternating layers, which stand out in sharp contrast because of marked difference in composition and color, furnishes strong evidence that this distinct banded effect is due to differences in original sedimentation. A great mass of igneous rock is generally characterized by homogeneity throughout; a mass of typical sediments, on the other hand, is arranged in distinct layers, such as shale, sandstone, or limestone which show frequent differences in composition. In the Grenville, especially of

the northwestern and southeastern Adirondacks, there are extensive beds of crystalline limestone, such as the Gouverneur marble of St Lawrence county. Such rocks could not have been of igneous origin. In many places, and sometimes in sharp contact with the limestone, are beds of almost pure quartz rock, which are certainly not igneous but which represent original sandstone layers. Again, there are very extensive deposits throughout the Adirondacks of generally darker colored rocks rich in such minerals as quartz, feldspar, garnet, mica, pyroxene, and amphibole. These rocks, because of their constant close association with the strata just described as well as their banded structure, are also clearly ancient sediments. The composition of these latter rocks shows that the original sediments were muds, often with sand or lime. Another argument in support of the sedimentary character of the Grenville is the presence of flakes of graphite (plumbago) which are so commonly disseminated throughout the formation. In some places the strata are so filled with graphite that the mineral is mined, as in Essex and Saratoga counties. Carbon existing under such conditions is probably of organic origin and represents the final stage in the decomposition of organisms which lived in the waters while the Grenville strata were being deposited. The occurrence of so much garnet is also at least highly suggestive because this mineral is especially common in crystallized sediments in many parts of the world.

Having established the sedimentary origin of the oldest known formation in New York State, we are led to the interesting and important conclusion that this Grenville formation is not the oldest which ever existed in the State. The Grenville sediments must have been deposited, layer upon layer, upon a surface of still older rocks. A knowledge of the character and composition of such Pregrenville rocks would be of very great interest, but thus far we have no positive evidence that such rocks are visible in the Adirondacks, although certain rocks still of somewhat doubtful age and origin may belong to that very ancient rock floor. Again, the fact that Grenville sediments were being deposited under water carries with it the corollary that there must have been land somewhere at no great distance from the area of deposition because then, as now, such sediments as muds and sands could have been derived only from the erosion or wearing away of land and have been deposited in great sheets one above the other, under water adjacent to the land mass. Here, too, we are as yet utterly in the dark so far as any knowledge of the location or character of that very ancient land is concerned.

Plate 13

An outcrop of typical Grenville (Precambric) limestone showing the folded or contorted and streaked character of the rock. View taken 1½ miles southeast of Johnsburg, Warren county.

W. J. Miller, photo

DISTRIBUTION, THICKNESS AND AGE OF THE GRENVILLE

The Grenville is associated with rocks of younger age in the Adirondack region, so that the formation is not present as a single, continuous mass of surface rock covering the whole area. It is, however, so abundant and widespread in great and small areas throughout the Adirondack province that we may confidently assert that this whole district was under water during Grenville time. As the geologic structure strongly suggests and as certain deep wells prove, rocks of this age must extend, under cover of the later Paleozoic sediments, for a considerable distance beyond the Adirondack area. Precambric rocks have long been recognized in the Highlands district of the lower Hudson and recent work makes it practically certain that strata of Grenville age exist there. Precambric (doubtless including Grenville) occurs along the western border of New England and it should also be mentioned that Grenville strata are extensive over much of southeastern Canada. Presence of Grenville strata in southwestern New York is somewhat doubtful because, if there, they are effectually concealed under the heavy cover of Paleozoic strata. The positive existence of Grenville, however, just to the north in Canada and in northern and southeastern New York, makes it more than likely that the Grenville underlies the Paleozoic rocks of western New York also. Such a widespread distribution of the Grenville sediments shows that deposition went on in a very large body of water; large enough, in fact, to be called an ocean. *Thus, bearing in mind all the facts, we are led to the important conclusion that, during Grenville time, all of northern and eastern and probably southwestern New York was under the sea. In other words, the most ancient known geographic condition in New York was a great expanse of ocean water covering most, if not all, of the State.*

As the rocks are badly disturbed and folded, and as the top or bottom of the formation has never been recognized as such, it is impossible to give anything like an exact figure for the thickness of the Grenville rocks. Continuous successions of strata have been observed in enough places, however, to make it certain that Grenville strata were piled, one layer upon another, to a thickness of many thousands of feet. This clearly implies that the Grenville ocean existed for a vast length of time which must be measured by no less than a few million years, because in the light of all our knowledge regarding the rate of deposition of sediments, such a very long time was necessary for the accumulation of so thick a mass of rocks. It does not necessarily follow that the Grenville

ocean was thousands of feet deep when the deposition began, because there may well have been a gradual subsidence of the sea floor during the process of sedimentation, which means that there was not necessarily very deep water at any time. In fact, the very character of the sediments clearly indicates that the Grenville ocean was, for most part at least, of shallow water, for such sediments as sands and muds have rarely if ever been carried far out into an ocean of deep water. The great ocean abysses of today are not receiving any appreciable amount of land-derived sediments. Hence it is practically certain that the very ancient Grenville sea bottom gradually settled as the sediments accumulated. Similar phenomena are definitely known to have occurred in many later basins of deposition.

The reader may naturally be disposed to ask, How long ago did the Grenville ocean exist? There are grave difficulties in the way of answering this question in terms of years, as we have nothing like an exact standard of this kind for comparison. While it is fully recognized that not even approximate figures can be given, a very conservative statement would ascribe an age of twenty to twenty-five million years to the Grenville strata. Whatever its exact duration may have been, the time is utterly inconceivable to us, and the important thing to bear in mind is that the great events of earth history which have transpired since that time require a lapse of many million years as shown by the enormous accumulations of sediments in many parts of the earth, and by the building up and wearing away of one great mountain range after another. The reader will better appreciate the significance of these statements after he has studied the following pages. In the table of geological time divisions given in chapter 1, the two oldest periods are the Archean and Algonkian respectively. The Grenville can not with certainty, as yet, be placed in either of these periods, although according to the best evidence it should be classed with the Archean. In the meantime it is advisable to refer to all formations older than the Paleozoic simply as Precambric.

LIFE IN THE GRENVILLE OCEAN

All that can be said regarding the life of the Grenville ocean is that it existed as indicated by the presence of the graphite. Although we can not even state whether the organisms were plant or animal, the fact that there was life in that very ancient ocean is a matter of no little significance. Anthracite coal, which is chemically

very similar to graphite, occurs in the Carbonic strata of Pennsylvania, and is derived from plants through the process of carbonization. Graphitic anthracite of like origin occurs in a smaller way in Rhode Island. Hence it seems likely that the graphite of the Grenville represents the remains of plants, probably of the seaweed type since there is much evidence against the view that any of the higher land plants existed at that very early time. This by no means proves the absence of animals from the Grenville ocean, because animals with only soft parts would have left no record, while calcareous or silicious shells would doubtless have been recrystallized by the severe processes of metamorphism to which these rocks have been subjected.

EARLY PRECAMBRIC IGNEOUS ACTIVITY

After the accumulation of the Grenville sediments, igneous activity, took place on a large scale, when great masses of molten rock were pushed or intruded into the sediments from below. Several different times of igneous activity have been definitely recognized and the general effect of the great invasions of molten rocks was to break the Grenville up into patches. In many cases considerable masses of Grenville were pushed aside or displaced by the molten masses while, to a greater or less extent, there may have been an actual melting in or assimilation of Grenville rocks by the molten intrusions. As we have already learned, igneous rocks are those which have cooled from a molten condition, and of these there are two important types, called respectively, plutonic and volcanic. Both of these types of igneous rocks are found in the Adirondacks, but the plutonics are by far the more prominently developed.

So far as we know, the first great intrusion of molten rock in the Adirondacks is represented by the present large area of so-called anorthosite in Essex and Franklin counties. This is a very coarse-grained, plutonic rock of bluish gray color when fresh and consists chiefly of a feldspar (labradorite). The intrusion was practically confined to a single area comprising about 1200 square miles. That this rock is younger than the Grenville is demonstrated by the fact that tongues of the anorthosite have been observed cutting through the Grenville (see figure 12). This intrusion differs from the later intrusions in that it was practically a single great mass which broke its way through the Grenville in but one place in the whole Adirondack region. In a few cases small patches of Grenville were caught in the molten flood and may now be seen within the anorthosite mass. For the most part, however, the molten rocks

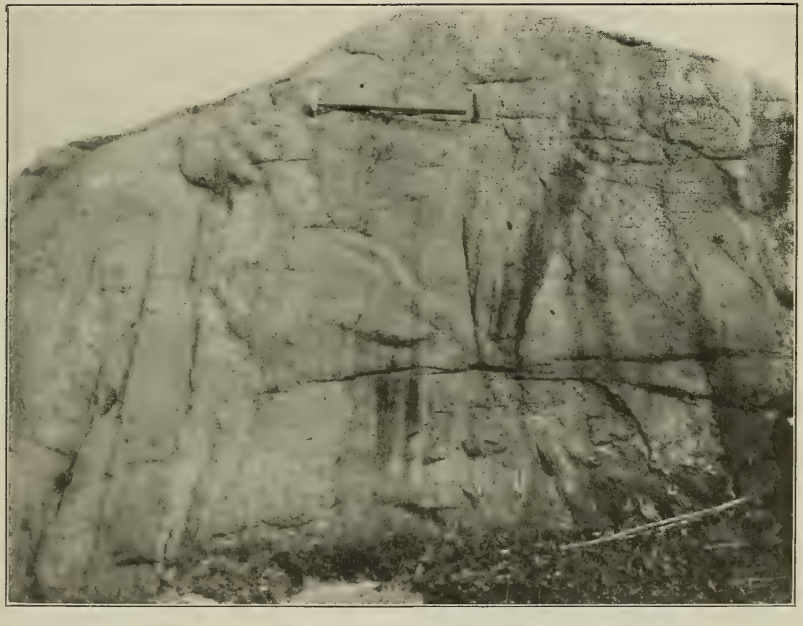
either completely pushed aside the Grenville or melted it into itself, the former being the more likely. Many of the highest points within the Adirondacks, like Mt Marcy, are in this anorthosite area.

The next clearly recorded event, after the anorthosite intrusion, was very widespread igneous activity when the rocks of the granite-syenite series, now so well known in the Adirondacks, were forced upward into the Grenville sediments. To be precise, there were at least two or three periods of intrusions of such rocks, the oldest probably being represented by the so-called Laurentian granite of the Thousand Islands region. For our purpose it will suffice to regard these as having all been intruded at about the same time, since the sum total of effects is much the same as though there had been but a single period of activity. Granite is a plutonic, igneous rock which consists essentially of quartz and feldspar (orthoclase),

FIG. 12 Generalized section showing the relations of the most common Precambric (Adirondack) rocks to each other and how their relative ages are determined.

together with more or less black mica, hornblende, or augite. Syenite is the same except that quartz is much less prominent or lacking. The fresh rock is of a greenish gray or pinkish gray color, while on weathered surfaces the color is usually light brown. Many of the highest mountains outside the anorthosite area are of granite or syenite.

The present distribution of these rocks shows that the molten masses broke into the Grenville in very irregular fashion, sometimes pushing the Grenville aside; sometimes enveloping great or small masses within the molten flood; or, in other cases, apparently leaving large Grenville masses intact. All portions of the Adirondacks felt the force of the intrusions and a detailed geologic map of the region would show a decided patchwork effect (see figure 13) due to the irregular manner in which the Grenville has been cut up by the igneous rocks. These igneous rocks are generally easily distinguished from the old sediments because of their homogeneity in



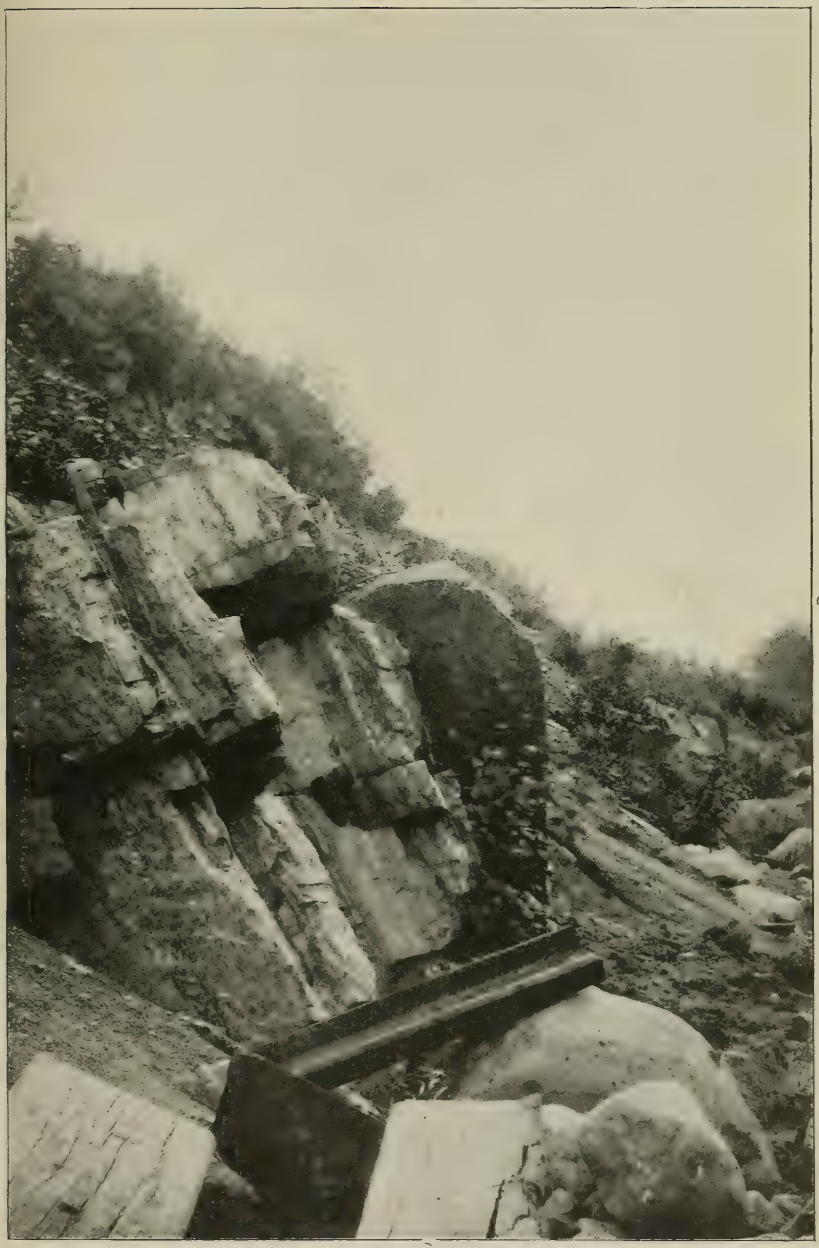
Upper figure. Typical outcrop of Adirondack Grenville gneiss, showing distinct stratification and tilted beds. Three-quarters of a mile north-northeast of Batchellerville, Saratoga county.

From N. Y. State Mus. Bul. 153, pl. 1

Lower figure. Typical outcrop of Adirondack syenite (igneous rock) at Harrisville, Lewis county.

From N. Y. State Geol. Rep't 1897, facing p. 1470

Plate 15



A ledge of Precambric rock near Loon lake in the northern Adirondacks, showing the very ancient Grenville gneiss in sharp contact with syenite. The light and dark banded rock on the right is Grenville and the hammer is on the contact.

From N. Y. State Mus. Bul. 5, pl. 3

large masses and lack of sharply defined bands of varying composition.

That these granite-syenite rocks are younger than the anorthosite is demonstrated by the fact that tongues of the former have been observed to cut the latter (see figure 12). Since the granite and syenite now visible in the Adirondacks are plutonic rocks, they

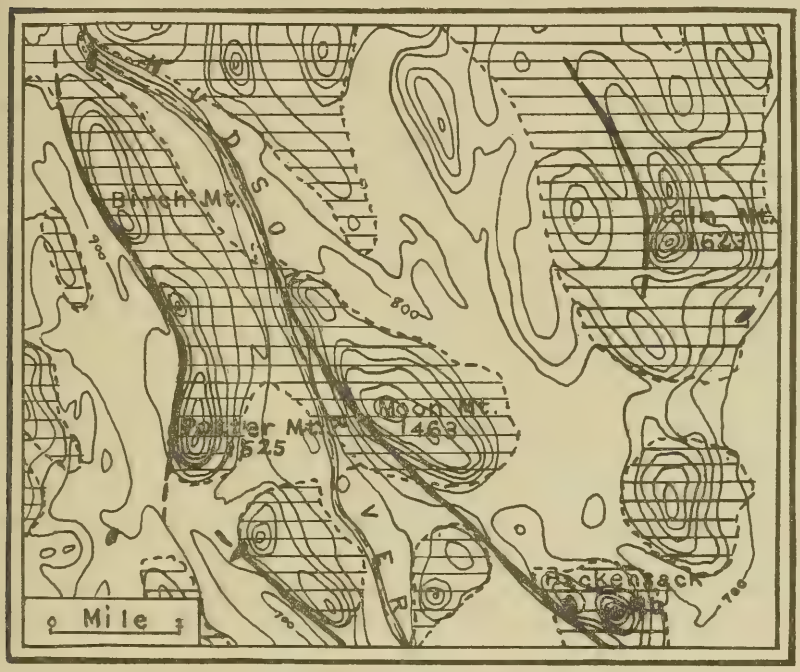


FIG. 13 Geologic and topographic sketch map of the southeastern portion of the North Creek sheet (Warren county), showing the surface relations of the common Precambric rocks in the southeastern Adirondacks. Contour interval 100 feet. Horizontally lined areas = syenite or granite; blank areas = chiefly Grenville; small heavy black lines are faults. The faults here shown are minor ones which do not follow the NE-SW trend of the major faults of the eastern Adirondacks. The so-called "patch-work" effect is well shown. Note how the more resistant rocks form the mountains which rise above the general level of the Grenville. (W. J. M.)

could not have reached the surface by intrusion, as such rocks can be formed only by slow cooling under great pressure thousands of feet below the earth's surface. They now appear at the surface because of vast removal, by erosion, of the overlying original materials.

It should be stated that this period of igneous activity is by no means confined to the Adirondacks. Similar intrusions are known in the Highlands-of-the-Hudson and in Canada. The covering of Paleozoic strata in southwestern New York prevents direct observation, but all things considered, it is more than likely that much or all of that part of the State, stripped of the Paleozoics, would also show Grenville cut up by granite and syenite.

FOLDING OF THE ROCKS AND UPLIFT OF THE ADIRONDACKS

At some time after these great periods of igneous activity and cooling of the rocks, the whole Adirondack region was subjected to an enormous pressure as a result of which the rocks were highly folded and compressed. The Grenville strata now seldom lie horizontally but are tilted at all sorts of angles, and even the igneous rocks thus far described, show unmistakable evidence of having been greatly compressed because the minerals are flattened out or arranged in parallel fashion, often exhibiting a crude, banded structure. Rocks which have thus been changed are known as gneisses and may be either igneous or sedimentary.

Still later than the granites and syenites, there occurred intrusions of gabbros in the form of dikes or fissures filled with igneous rock. This gabbro is a very dark gray, rather coarse-grained, plutonic rock, and it has been found in numerous small masses throughout the Adirondacks, but especially in the eastern portion. Its age, younger than the granite-syenite series, is demonstrated by the fact that it often breaks through those rocks, and also because it is not nearly so much metamorphosed.

The Grenville sediments were completely crystallized as a result of this metamorphism so that all beds of limestone were converted into marble, sandstone into quartzite, and the shales into gneisses of varying character. Thus the Grenville strata have been very greatly altered from their original condition, which explains why they do not look like the more typical and familiar sediments of later age. The manner in which the Grenville strata, especially the limestones, were crumbled and folded shows that the rocks must have been in a more or less plastic condition when the pressure was exerted (see plate 13). Heat and moisture, no doubt, aided in this process which we call metamorphism. Such a process can take place only at thousands of feet below the surface of the earth where the rocks, under the enormous weight of overlying material, would act like

View of Breakneck mountain where the Hudson river cuts across the Highlands. Seen from the shore opposite Cold Spring, Putnam county. The rock is Precambric granite. Back from the river, in these mountains, the character of the topography is much like that of the Adirondacks.

From N. Y. State Mus. Bul. 19, pl. 11

plastic masses when subjected to any great lateral pressure within the earth.[1]

Rocks at the surface of the earth, subjected to the same lateral pressure, would be broken or fractured instead of bent or folded. It is not the present purpose to discuss the origin of such pressure within the earth, but suffice it to say that it is somehow due to the shrinkage of the interior portion of the earth, and the tendency of the exterior (or crust) to accommodate itself to the shrinking interior, thus producing lateral thrust (pressure) in this exterior portion.

We are now ready to discuss the first known uplift of the whole Adirondack region above sea level, or what we may call the birth of the first known Adirondack mountains. As we have just learned, the very character and structure of the rocks now exposed in the region, show conclusively that they were at one time deeply buried under thousands of feet of overlying materials, and the inference is perfectly plain that those materials must have been removed by erosion. Extensive erosion of any land mass means that the land must be above sea level and thus we come to the important conclusion that *the great mass of Grenville sediments were upraised well above sea level.* Just when the great uplift occurred can not be positively stated, but if it was not during, or after the igneous intrusions, it must have been shortly before them. It is quite reasonable to believe that the same great force which caused a welling up of so much liquid rock might easily have caused a decided uplift of the whole region. Again, it is quite plausible that there may have been no great uplift until the development of the lateral pressure which caused the metamorphism of the rocks. Still another view is that a lateral pressure, once started, first caused a welling up, at different times, of igneous rock and then, after the cessation of the igneous activity, the same force continued to compress, fold and metamorphose the rocks. Whatever the actual history may have been, it is at least true that the sum total of all effects, as we now observe them, harmonizes well with the view last expressed. The intense folding and tilting of the strata show that the amount of uplift must have been very considerable as is the case in all typical mountain ranges. We can not, however, even state the approximate height of those very ancient Adirondack mountains. The fact

[1] Professor Adams of McGill University, Montreal, has recently proved experimentally that rocks, under great pressure, flow like plastic matter.

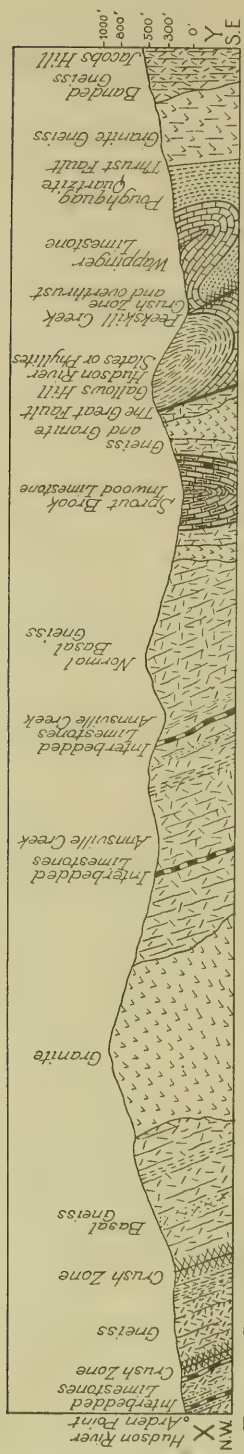
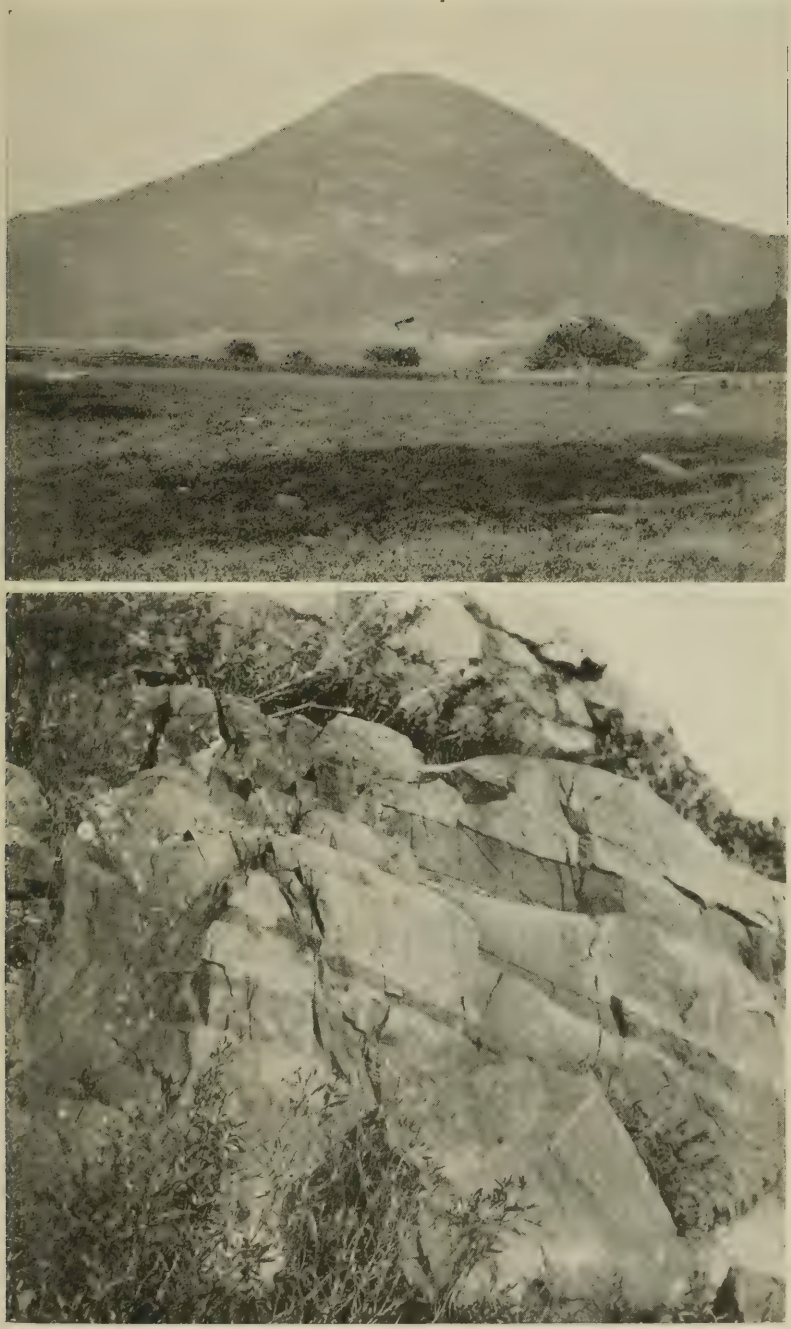


FIG. 14 Structure section through a portion of the Highlands-of-the-Hudson from a point on the river one mile south of Garrison and extending 6 miles southeasterly to Jacob's hill. The basal gneisses are highly metamorphosed and folded Precambric (Grenville?) sediments through which large masses of granite were erupted. Toward the right are closely infolded belts of early Paleozoic sediments.

After C. P. Berkey, N. Y. State Mus. Rep't 60, v. 2, 1906, p. 371



The upper view is of Potash mountain, locally called the "Potash Kettle," three miles north of Luzerne, Warren county. It is a remarkable feature of the landscape, the almost isolated mountain towering 1100 feet above the surrounding valleys. The rock is Precambric granite.

The lower view shows several dark lava (diabase) dikes cutting gray syenite three-fourths of a mile northwest of Northville, Fulton county. Both rocks are of Precambric age. Photos by W. J. Miller

that many thousands of feet of materials have been removed by erosion in order to expose the present rocks to view does not necessarily imply that the mountains at any time had so great a height because it is possible that, while elevation slowly progressed, material was steadily removed by the process of erosion. All our knowledge regarding later and better known mountains, however, leaves little doubt that those first Adirondacks were mountains vastly higher than those of today.

The same sort of uplift and succeeding profound erosion also affected the present region of the Hudson Highlands (see figure 14) and, this being the case, we can state with confidence that much, if not all, of northern and eastern New York was involved in this mountain-making process. For western New York the physical geography of this time has not been determined because all that region is so deeply buried under the Paleozoic strata.

LATE PRECAMBRIC HISTORY

The fact that such a great thickness of rock was removed by erosion implies a vast length of time for the accomplishment of that work. According to all that we know regarding the rates of erosion of mountains of the present and past, the erosion of the Adirondacks must have extended over a period of at least several million years. When we consider that, at the opening of Upper Cambric time, most of the region had been worn down to the condition of a peneplain (see page 42), we are confident that no small amount of the erosion was accomplished even before the opening of the Paleozoic era, and that it continued well into the early Paleozoic. The whole problem of this later erosion and its effects will be treated in the next chapter.

Well toward the end of Precambric time, igneous activity of a minor character took place in the formation of dikes which, as we have learned, are fissures in the crust of the earth which have been filled with molten rock. In the Adirondack region there are several kinds of dike rocks, the most common being pegmatite and diabase. Pegmatite is a very coarse-grained, light colored rock of general granitic composition, the feldspar and quartz crystals often attaining lengths of several inches to a foot. Diabase is a fine-grained rock much like ordinary basaltic lava. These dikes are generally less than a mile long and comparatively narrow. That they are younger than the other igneous rocks of the region is abundantly proved by the fact that they cut through those rocks in many places

(see plate 17 and figure 12). That these dike rocks were intruded after the great pressure and uplift of the region is shown by the total absence of metamorphism or alteration of any kind along their contact lines. The fine-grained texture of these rocks, often with borders of glass, shows that they must have cooled close to the surface, and hence it is evident that most of the Precambric erosion of the region had been accomplished before the diabases were erupted. Such rocks suggest that there may have been volcanic activity at the surface but no positive proof for such activity can be given because, if such volcanic material ever existed, every trace of it has been removed by erosion. The diabases have been observed to cut the pegmatites and hence they are not only the younger of the two, but they must take rank as the youngest Precambric rocks in the State. In the Adirondacks the pegmatites are very widely distributed and common, while the diabases are most abundant in the northeast, less so in the northwest and southeast, and nearly absent from the southwest.

Chapter 4

PALEOZOIC HISTORY

CAMBRIC PERIOD

In the preceding chapter we have seen that after the first known great Adirondack uplift the whole region, including the district of the Highlands-of-the-Hudson, was profoundly affected by erosion, and that this erosion began before the Paleozoic age and extended well into the early part of that era. Now the question may be fairly asked, What became of the sediments which were derived from the wearing down of the land during that vast length of time? We must admit that, in our present state of knowledge, we can not be certain as to what became of the Prepaleozoic sediments. They may have washed westward or southwestward into waters which might possibly have existed there; or they may have been carried northward or northwestward into Canada to help build up late Precambric deposits there; or they may have moved eastward toward or into the Atlantic basin. The question of the disposition of the early Paleozoic sediments, however, can be much more satisfactorily answered. Early and Middle Cambric deposits are extensively developed in the New England states and along the eastern border of New York State, including the Hudson Highlands region. Thus we have positive proof for the presence of the early and Middle Cambric sea over this region, and it is equally evident that much of this sediment which deposited in the sea was derived from the adjacent land masses in northern and eastern New York.

It was not until the opening of the Upper Cambric (Potsdam time) that any considerable portion of New York State was occupied by Paleozoic sea water. The fact that all the Cambric strata, including Lower, Middle, and Upper, are present in the New England country and along the eastern border of New York, while only the Upper Cambric is present in northern New York, clearly shows that the Cambric sea encroached upon the State from the east toward the west. To be more exact, it was probably from the northeast, because the greatest thickness of Upper Cambric strata is in Clinton county along the northeastern side of the Adirondacks.

The first deposit to form in the Cambric sea of northern New York was the Potsdam sandstone and the presence of this formation in the St Lawrence, Champlain, and lower Mohawk valleys

proves that the Potsdam sea occupied all these regions. Along the southwestern border of the Adirondacks the Potsdam is absent and there is not the slightest evidence that it ever was present, so that region must have been dry land in Potsdam time. In the southeastern Adirondacks the Potsdam sea certainly extended in as far as Wells (southern Hamilton county) and North River (northwestern Warren county), because small outlying masses of Potsdam sandstone occur at those places. These outlying masses were formerly connected with the larger areas but have become completely separated from them by extensive (Postpaleozoic) erosion and downfaulting. There is no evidence whatever that the sea covered the heart of the Adirondacks. *To summarize for northern New York, we may say that the Potsdam (Upper Cambric) sea covered the whole region except the central and southwestern Adirondacks which stood out as a great island in the midst of that ocean.* Southeastern New York certainly, and the middle eastern border of the State probably, were covered by the Upper Cambric sea, but whether that sea extended over the rest of the State has not been determined because all early Paleozoic strata, if present, are now deeply buried.

What do we know about the character of the topography of the land over which that ancient Potsdam sea spread? As a result of the very long erosion during late Precambric and early Paleozoic, thousands of feet of material had been removed so that rocks which had been so deeply buried were exposed at the surface, and the whole country must have been well worn down. Was the region worn down to the condition of a peneplain? Recent detailed studies on all sides of the Adirondacks furnish a very satisfactory answer to this question. In many places the Potsdam has been seen in actual contact with the Precambric rock whose surface oftentimes clearly proves that the whole region had reached a peneplain condition. Along the northeastern Adirondacks this peneplain was considerably rougher than along the northwestern and southwestern portions. This is explained by the fact that the northeastern area subsided first and consequently was not subject to wear quite so long as the latter named areas.

The accompanying figure (no. 15) affords an interesting example of the kind of peneplain topography here considered. It demonstrates that occasional low knobs of more resistant rock (for example, Grenville quartzite) protruded above the otherwise nearly featureless plain, because when the Potsdam sea overspread the

Plate 18

The Grand Flume of Ausable chasm, Clinton county. The rock is Potsdam sandstone in horizontal layers and the gorge is postglacial.

From N. Y. State Mus. Bul. 19, pl. 22

Potsdam (Upper Cambric) sandstone resting upon the eroded surface of Precambric rock (gneiss) at Corinth, Saratoga county. The difference in age of the two rock masses here in contact is millions of years.

From N. Y. State Mus. Bul. 19, pl. 20

region such low knobs were not covered by the water. At this same locality there is a fine exhibition of coarse conglomerate at the base of the Potsdam sandstone, the boulders of the conglomerate often ranging from one to three feet across. These boulders were torn off the Adirondack cliffs by the waves of the Potsdam sea and were deposited near shore in local depressions of the old rock surface. The sandstone itself everywhere abounds in ripple marks, thus proving the shallow water (near shore) origin of the rock. All the rock in the walls of the famous Ausable Chasm (Clinton county) is Potsdam sandstone (plate 18).

Immediately overlying the Potsdam and showing about the same areal distribution, are alternating sandstones and limestone beds (Theresa formation) which show a thickness of from 50 to 200 feet. After still greater subsidence, the important formation known as the Little Falls dolomite (limestone) was deposited, layer upon

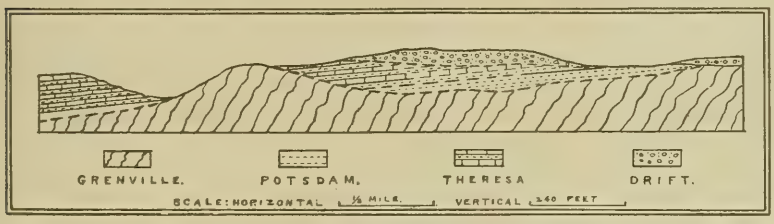


FIG. 15 Section passing through North Galway in Saratoga co. and showing how the Cambric (Potsdam and Theresa) strata overlap upon a hillock of Precambric rock. This knob of Precambric rock stood above the general level of the peneplain (early Paleozoic) and was not submerged under the Potsdam sea.

After W. J. Miller, N. Y. State Mus. Bul. 153, p. 5

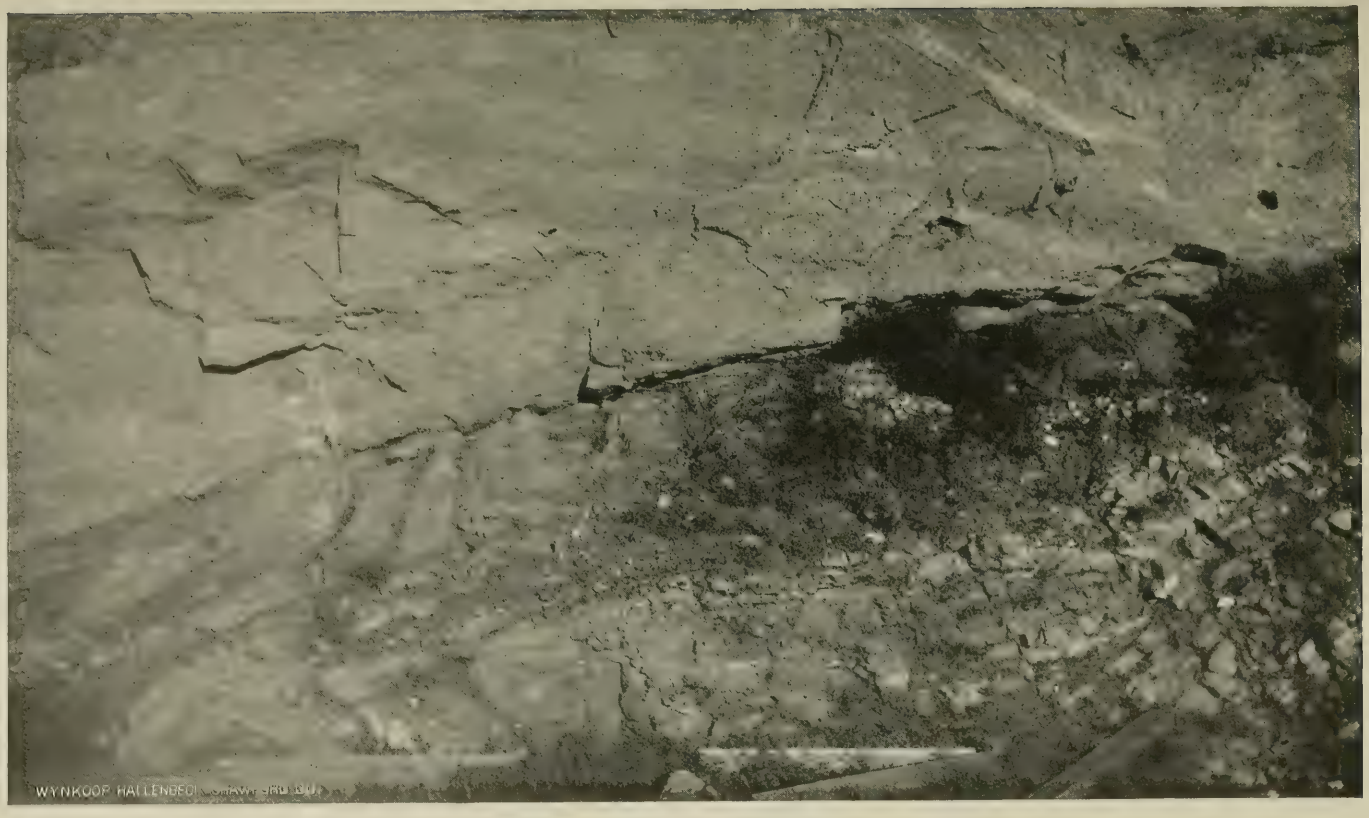
layer, in the Upper Cambric sea. This formation which is hard, compact and of light gray color, shows a thickness of several hundred feet in the gorge at Little Falls. It rests directly upon the Precambric rock there (see figure 7), which shows that the Cambric sea spread over that region for the first time when that dolomite was forming. The Little Falls sea swept all around the Adirondacks, except what is now the western border from Trenton Falls to the Thousand islands district. Occurrence of the dolomite in small outlying masses at Wells (Hamilton county) and Schroon Lake (Essex county) proves that the Little Falls sea extended well into the eastern Adirondacks. Rocks of this age appear to be present in southeastern New York and if so, the Little Falls sea also overspread that region. Direct evidence for western and southern

New York is wholly lacking, but judging by the occurrence in central Pennsylvania of rocks of the same age as the Little Falls dolomite, it is highly probable that the Little Falls sea also covered western and southern New York.

The Little Falls dolomite is especially significant in two ways; first, because it is the youngest (uppermost) Cambric formation in the State, and second, there is a distinct unconformity at its summit. By unconformity here we mean that, after the deposition of the dolomite, at least all of northern New York was raised (without folding or faulting) above sea level and underwent erosion for a moderate length of time after which most of the region again settled below sea level to receive the deposits of later (Ordovicic) age. This old eroded surface and unconformity has been well established, and hence we learn that *the great Cambric period of the early Paleozoic era closed with all of northern New York, at least, well above sea level.* In southeastern New York, so far as known, the Cambric strata appear to grade into the Ordovicic and, if so, that region was not raised above sea level at the close of the Cambric. We are wholly ignorant as to the physical geography of western and southern New York at the close of the Cambric because the records there are not accessible, as they are deeply buried.

ORDOVICIC PERIOD

We are now ready to consider the physical condition of the State during the great Ordovicic period of earth history. During this time the Appalachian mountain region, the great Mississippi valley, and much of the far western region were almost continually under water (see figure 16). In fact, the very widespread distribution of thick Ordovicic strata shows that more of North America was covered by the Ordovicic sea than by any other sea, with the possible exception of the Precambric. Among the more prominent lands which persisted above water were Appalachia, a great land mass occupying what is now the Atlantic sea board and extending an unknown distance into the Atlantic, and another large land area in the Hudson Bay region of Canada. Sediments from those lands were washed into the Ordovicic sea which, for most part at least, covered the State during the entire period. In eastern and southeastern New York, the almost unbroken succession of Ordovicic strata shows that the sea was much of the time present there during the entire period. The prominent development of Ordovicic strata west and south of New York makes it practically certain



Little Falls (late Cambric) dolomitic limestone resting upon the eroded surface of Precambric rock as seen in a West Shore Railroad cut 1 mile west of Randall, Montgomery county.

From N. Y. State Mus. Bul. 19, pl. 25

that the western and southern portions of the State were submerged under the Ordovicic sea. In northern New York, however, there is no positive evidence whatever that the whole Adirondack area was ever completely submerged during this period. Accordingly the central Adirondacks formed a persistent island in the Ordovicic sea. Furthermore, in northern New York there were various rather

FIG. 16 Generalized map of North America showing the relations of land and water during the Midordovicic period. Horizontally lined areas = land; blank areas = water. All of New York State was submerged except the central Adirondacks which stood out as an island. The conditions in Mexico and Central America are practically unknown.

local oscillations of level bringing the land around the island now above and now below sea level, but all such details are here omitted. For our purpose it will suffice to say that, except for the Adirondack island, northern New York was mostly below sea level during the Ordovicic. To summarize the above statement: *New York State*

was completely submerged under the Ordovicic sea except for the Adirondack island and alternating land and water conditions immediately around that island.

Without going into the details of the formations, it is important to note that the earlier Ordovicic deposits were almost wholly limestones, while the later deposits were nearly all shales and sandstones. Thus in southeastern New York the thick Wappinger limestone is overlain by the still thicker Hudson River shales and sandstones. In northern New York we have the Beekmantown, Chazy, Black River, and Trenton limestones overlain by the Trenton (Canajoharie), Utica, and Frankfort shales and sandstones. It should not be understood, however, that all the formations named are present in unbroken succession, because the oscillations of level (above mentioned) occasioned certain interruptions in sedimentation.

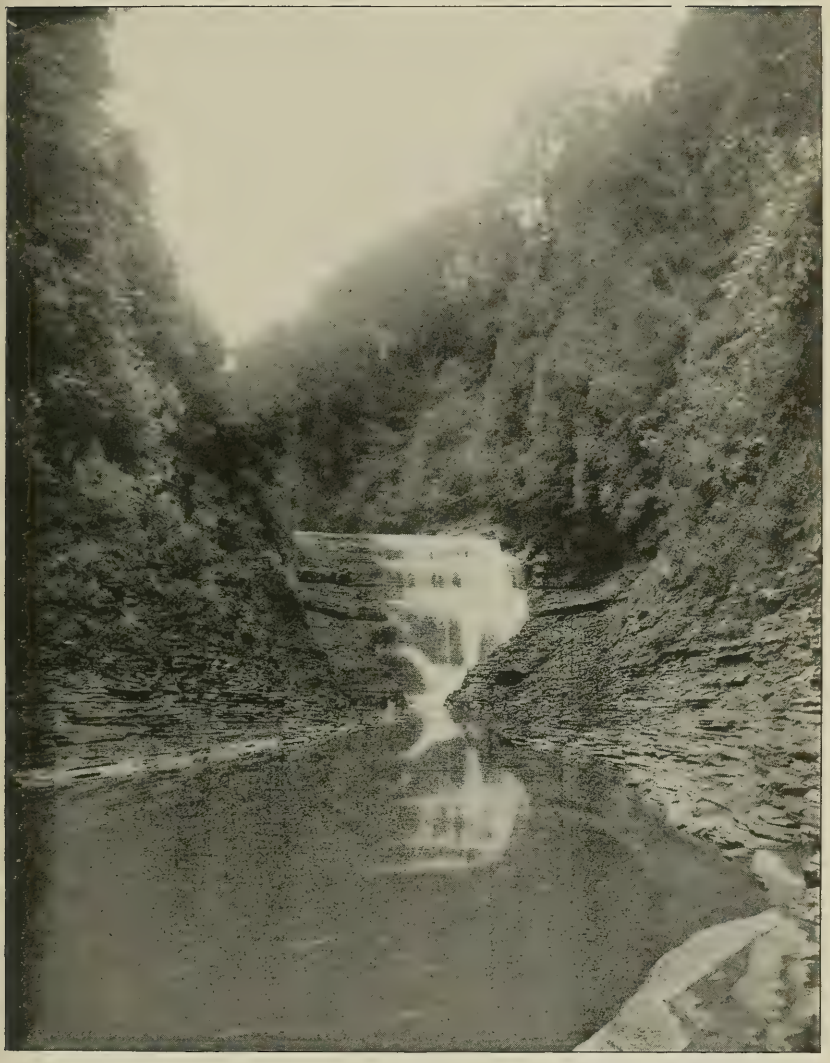
The predominance of limestone formation in the earlier Ordovicic sea of New York proves that the waters of that time were comparatively free from land-derived sediments and this, in turn, is best accounted for not by great depth of water and distance from land, but rather by the fact that all the nearest land areas were comparatively low and small, and hence were not undergoing very active erosion. During the later Ordovicic the adjacent lands were considerably higher and no doubt larger, so that vigorous erosion resulted and muds and sands were largely washed into the sea.

The aggregate thickness of Ordovicic strata in New York is between 2000 and 3000 feet. It should not be inferred from this fact that the Ordovicic sea was ever two or three thousand feet deep. Even the limestones abundantly show by ripple marks, mud cracks, fossils etc. that they were laid down in shallow sea water. The very character of the materials (old muds and sands) in the Upper Ordovicic formations shows that they could not have been deposited in deep ocean water. Such sediments are not now forming on the deep sea bottom. But how are these statements to be harmonized with the fact that nearly 3000 feet of Ordovicic strata exist in New York? During the whole period (with certain exceptions above noted) the land gradually subsided and in this slow downward movement stratum after stratum was formed upon the sinking sea-floor, so that at no time is it necessary to assume great depth of water. In general, the Ordovicic sea of North America must be thought of as a vast shallow (continental) sea which spread over most of the slowly subsiding continent. There were no ocean abysses at all comparable to those of the present ocean.

Trenton (Ordovicic) limestone at Sherman fall in the gorge at Trenton Falls, Oneida county. The thin-bedded and perfectly stratified character of this impure limestone is here well shown. This famous formation, loaded with fossils, was named from this locality.

From N. Y. State Mus. Bul. 95, pl. 9

Plate 22



Falls over Canajoharie (Trenton) black shale south of Canajoharie, Montgomery county.

From N. Y. State Mus. Bul. 19, pl. 35

In the strata of Cambric age in New York, animal or plant remains are comparatively rare, while the Ordovicic rocks throughout fairly teem with fossils. If any single formation deserves special mention, it is the Trenton limestone which is exceedingly rich in fossils. The type locality, at Trenton Falls, is justly famous as a collecting place for Ordovicic fossils. Among plants, none above very simple seaweeds or algae are known to have existed. Among animals, hundreds of species have been described as occurring in the Ordovicic strata of New York. These species represent all the more important subkingdoms and classes of animals below the vertebrates. Especially prominent are: corals, graptolites, star-fishes, brachiopods, gastropods and trilobites. All the organisms mentioned lived in the salt water, and if land life forms existed we know practically nothing about them. It must be borne in mind that not a single species of that time is known to live today, so complete have been the evolutionary changes since the Ordovicic age. Certain remarkable classes of animals like the graptolites and trilobites, which often fairly swarmed in the Ordovicic sea, have been wholly extinct for millions of years.

TACONIC MOUNTAIN REVOLUTION (CLOSE OF THE ORDOVICIC)

We are now ready to discuss the second well-known mountain-making epoch which affected New York State. We have learned that sedimentation along the middle eastern border and southeastern parts of the State was practically uninterrupted during all the Cambric and Ordovicic periods, and that some thousands of feet of strata had accumulated. At the same time extensive sedimentation was taking place in the seas which covered all the regions of the present Berkshire hills, Green and White mountains, as well as southward, at least as far as Virginia, over the region occupied by the present Piedmont plateau. *At or toward the close of the Ordovicic period a great compressive force in the earth's crust was brought to bear upon the mass of sediments which reached from north of New England to Virginia, or possibly farther southward. As a result of this compression the strata were tilted, highly folded, and elevated far above sea level into a magnificent mountain range known as the Taconic mountains.* In structure, the range consisted of a series of rock folds, both great and small, whose axes were parallel to the main axis of the range, that is north-northeast by south-southwest. Examination of figures 14 and 20 will give the

reader a good conception of the character of the folding. It is quite the rule throughout this region of Taconic disturbance to find the strata either on edge or making high angles with the plane of the horizon. Many times the folds were actually overturned, and at times notable thrust faults or fractures[1] were developed, that is, the strata sometimes broke across and one great mass was pushed over another, as is well shown in many places in southeastern New York. These facts all go to indicate that the mountain-making compressive force applied to the region was of the extreme type, and though we have no way of telling just how high the range may have been, nevertheless the structural features and the vast amount of erosion since the folds were produced clearly indicate that the uplift was at least several thousand feet. The Green mountains, White mountains, Berkshire hills, Highlands-of-the-Hudson, and the Piedmont plateau are in a sense remnants of the great Taconic range.

In passing westward from the main axis of the Taconic range, the folding becomes less and less intense and finally dies out altogether. This fact is well illustrated by figures 6, 8 and 9. Along the Hudson river near Albany, the strata are fairly well folded, while a few miles westward the folds disappear. Passing eastward from Albany into Rensselaer county, one enters a region of excessive folding. In passing westward from Poughkeepsie, the intensity of the folding diminishes somewhat, but the shale formation is distinctly folded where it passes under the main mass of the Catskill mountains. Figure 6 clearly illustrates this fact.

How do we know that the Taconic disturbance occurred toward the close of the Ordovicic period? Another inspection of figure 6 will show that the strata of the next succeeding period (Siluric) rest directly upon the eroded edges of the folds of late Ordovicic rocks (see plate 25). Hence it is obvious that the disturbance occurred before the Siluric strata were deposited. What was the condition of the rest of the State just after the Taconic disturbance? In central New York, near Utica, a distinct eroded surface at the summit of the Ordovician shales proves that region to have been dry land toward the end of the period. On the north side of the Adirondacks and in the Champlain valley no formation younger than Ordovicic shale occurs, and all evidence points to uplift of that area into dry land toward the close of the period. Data are not obtainable for western New York. To summarize: *Practically all of northern-central, eastern, and southeastern New York (in-*

[1] See figures 23 and 24 for explanation of faults.

A small fold in the Hudson river (Ordovicic) shales and sandstones along the lower part of Catskill creek in Greene county. This fold was produced at the time of the Taconic revolution.

From N. Y. State Mus. Bull. 19, p. 36

cluding the great Taconic mountains) was dry land toward the close of the Ordovicic period, while the physical geography of western New York for that time is not certainly known.

It should be noted in passing that the rocks of the Highlands-of-the-Hudson were, for a second time, clearly involved in mountain-making disturbances. The structural features of the Taconic mountains are finely exhibited in southeastern New York from Poughkeepsie to New York City, where one literally passes across the roots of the former great range. The distinct northeast-southwest trend of the topographic relief in this part of the State is due to the fact that the relief is still largely controlled by the Taconic folds and faults. The Hudson river has cut a deep channel across these structure lines, and along its banks excellent opportunity is afforded for the study of the rocks, folds, faults etc.

Another feature which must not be overlooked is the profound metamorphism of the strata along the main axis of the range. The very intense compression, under very high moist heat, caused the deeply buried strata along the main axis of uplift to become rather plastic, and hence the sediments became more or less foliated and crystallized into the various metamorphic rock types, the limestone becoming marble, the shale becoming slate or schist, and the sandstone becoming quartzite. Thus we have extensive marble quarries in southern Vermont, the slate in the quarries of Washington county, New York, and the Berkshire schist in the Berkshire hills of Massachusetts. In passing down the Hudson river from Kingston to New York City, the several stages in the metamorphism of the Ordovicic slate formation are finely illustrated. Thus, from Kingston to near Poughkeepsie the strata are distinctly folded but not metamorphosed; from Poughkeepsie to the Highlands, the strata are highly folded and partially metamorphosed, the shale layers nearly always having been changed to slate, while the associated and more resistant sandstone layers have escaped change; from the Highlands to New York City the rocks have been highly folded and metamorphosed, both shale and sandstone having been converted into schist locally called the Manhattan schist. For example, the rocks exposed in Central Park are Manhattan schists which are believed to have been originally Hudson River shales and sandstones which have become thoroughly crystallized by intense metamorphism.[1]

[1] Professor Berkey has recently suggested the possibility that the Manhattan schist may be Precambric in age; if so, the latter part of this statement does not apply.

Accompanying the Taconic disturbance and possibly aiding the metamorphism were minor molten rock intrusions in the form of dikes. These dikes break through late Ordovicic strata and hence can not be older than late Ordovicic. A fine example of one of these dikes on Manhattan island is shown in plate 24.

The great compressive force which folded and upraised the Taconic mountains did not accomplish its work suddenly. The force was slowly and irresistibly applied and the mass of strata was gradually bulged and bent, or fractured if near the surface, the amount of time required for the whole operation being perhaps very long but beyond estimate. Such a length of time is, however, so short compared with all known geologic history that we are accustomed to refer to the formation of such a mountain range as simply an event of earth history.

From these statements we see that, even before the range had attained its maximum height above sea level, a very considerable amount of erosion must have taken place. When the very first fold appeared above the ocean level, erosion began its work and continued with increasing vigor as the mountain masses got higher and higher. Thus we have the warfare between two great natural processes — the building up and the tearing down. So long as the building up process predominated, the mountain range increased in elevation, and we say the range was in its period of youth. When the opposing forces were about equally balanced, the range tended to remain at a constant elevation and we say the mountains were in the period of maturity. When the tearing down (erosive) process was predominant, we speak of the range as having been in old age. When the mountains have been completely worn down close to sea level (peneplain) we speak of the death of the range.

Here is an example of one of the remarkable procedures of nature. After millions of years of work by the deposition of thousands of feet of strata, layer upon layer on an ocean bottom, a great compressive force is brought to bear and a magnificent mountain range is literally born out of the ocean. No sooner is this great mountain range well formed than the destructive processes unceasingly destroy this marvelous work. But the sediments derived from the wear of this range are carried into the nearest ocean again to accumulate and after long ages to be raised up into another range; and so the process is often repeated. From this we learn that the mountain ranges of the earth are by no means all of the same age. The Adirondacks are older than the Taconics, and these older than the Appalachians; the latter, in turn,

Granite dike in Hudson River or Manhattan schist, as seen on the south side of 192d street, New York City. The schist is metamorphosed Hudson River (Ordovicic) shale and sandstone and the granite, while molten, broke its way through. The steep tilt of the schist layers was produced by the Taconic disturbance.

From N. Y. State Mus. Bul. 19, pl. 1

being older than the Sierras and the Coast ranges. Much of the material making up the mass of the Catskill mountains was derived from the wear of the Taconic mountains, deposited in the sea just to their west and later raised high above sea level.

SILURIC PERIOD

The close of the Ordovicic age or the opening of the Siluric found practically all the State above sea level and undergoing erosion. Along the eastern side the great Taconic range stood out prominently, but over the rest of the State we have no evidence that the land was very high. The central portion of the Adirondack region probably stood out somewhat more prominently than the western region.

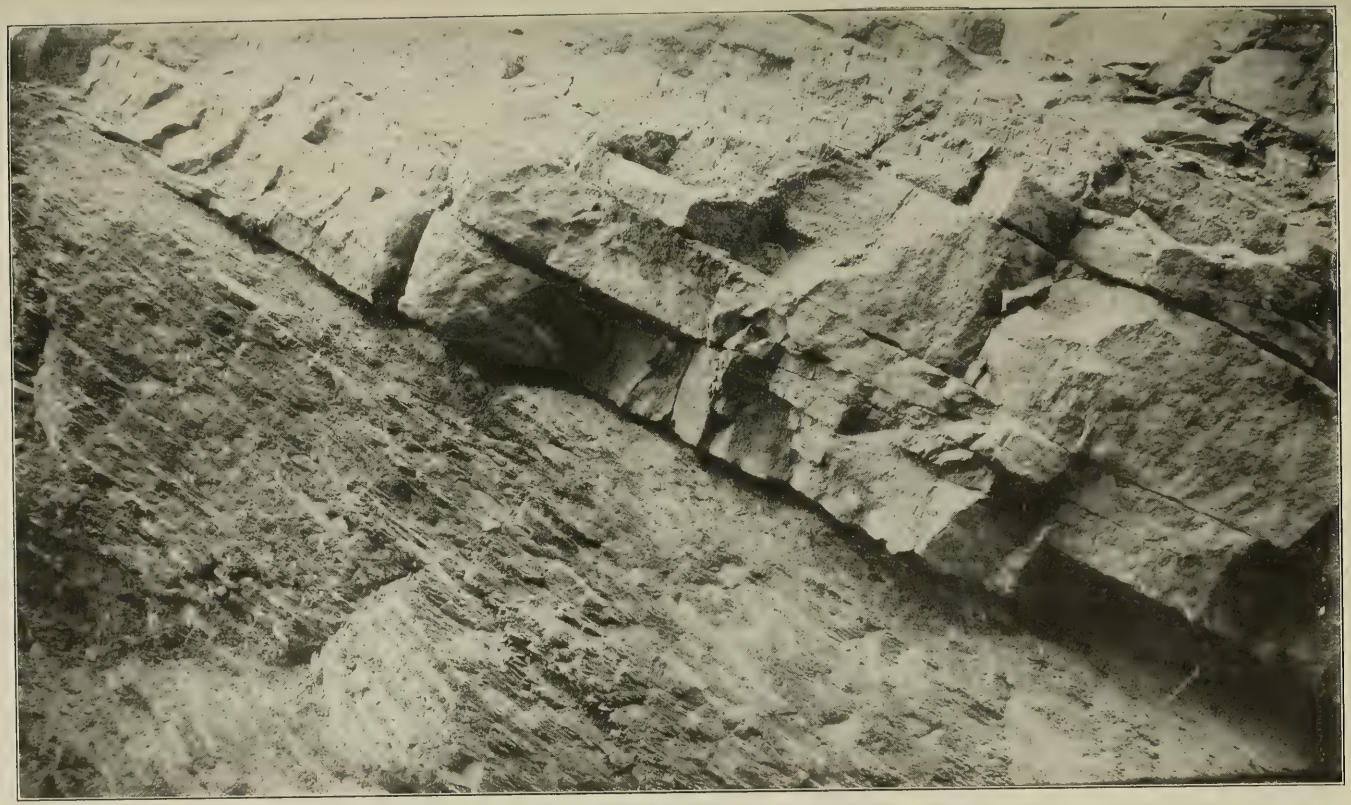
As shown on the geologic map (figure 1), the Siluric strata outcrops in a comparatively narrow belt which runs along the western side of the Hudson valley to the Helderberg hills, southwest of Albany, where it swings sharply around westward to follow the south side of the Mohawk valley, and thence as a somewhat wider belt along the south side of Lake Ontario. These Siluric strata everywhere dip under the Devonic (surface) rocks of the Catskill and Southwestern plateau provinces. This fact, combined with the knowledge that the strata are largely of widespread marine origin and also outcrop abundantly in central Pennsylvania, makes it practically certain that the Siluric rocks underlie all of the Catskill and southwestern plateau regions. *Thus we must conclude that at least during much of Siluric time all of New York State south of Lake Ontario and the Mohawk valley and west of the Hudson river, was covered by sea water.* That the earliest Siluric sea did not spread over the area is proved by the absence of the very earliest known Siluric deposits. Furthermore, we know that the sea transgressed upon the State from the south or west, the Taconic range forming an effective barrier on the east and total absence of Siluric strata in the St Lawrence and Champlain valleys (as well as in Canada just north of the State) precluding encroachment of the sea from the north.

This encroachment of the sea over so much of the State was due to a gradual sinking of the land. That central and western New York was submerged before the Hudson valley region is proved as follows: In central New York (south of Utica) the first deposit to form upon the eroded surface of the Ordovicic shales was the Oneida conglomerate which passes westward into the Medina sand-

stone. In southeastern New York (for example, the Shawangunk mountain) the first Siluric deposit to be laid down upon the eroded Ordovicic shales was the Shawangunk conglomerate. This latter formation, as determined by its fossils, belongs with the Salina division and is therefore much younger than the Oneida conglomerate which belongs with the Medina division (see table in chapter 1). Also the whole of the Clinton and Niagara formations, which are so well developed in central and western New York, were never formed in eastern or southeastern New York. Thus the Siluric sea, due to subsidence of the land, overspread central and western New York long before it reached the Hudson valley region. In fact it was not until late in the period that the sea encroached upon the Hudson valley area, and then it did not occupy all that area because the shore of the Siluric sea extended only as far east as the western slope of the Taconics. Western New York, during the late Siluric, was a more or less cut off basin or arm of the sea in which the salt beds were deposited.

How much, if any, of the Adirondack region was covered by the Siluric sea? The total absence of any formation later than the Ordovicic shales around the northern Adirondacks and across the line in Canada strongly suggests that this region was upraised toward the close of the Ordovicic period, perhaps at the same time as the Taconic revolution, and continued as dry land not only during the Siluric but also during all the ages up to the present, except for a very brief local submergence during the Quaternary (see figure 34). In the southern Adirondack area the case is somewhat different. The outcrops of Siluric strata beneath the steep front of the Devonic Helderberg escarpment immediately south of the Adirondacks, makes it certain that these strata and the Siluric sea formerly extended farther north. The difficulty comes in trying to decide how far northward these rocks once extended, because there is now not a single scrap of Siluric rocks north of the Mohawk river, though the cap rock (Oswego sandstone) of the Tug Hill plateau is probably of Siluric age. All we can say is that the Silurian sea probably overspread the southern border of the Adirondacks and that the sediments which were deposited there have since been removed by erosion. To summarize: *During the early Siluric the sea had spread over only central and western New York, while during the late Siluric it had extended over practically all the State west and south of the Adirondack region.*

The strata of Siluric age were deposited sheet upon sheet in the usual manner upon the sea bottom. For our purpose we may con-



Shawangunk (Siluric) conglomerate resting upon the eroded edges of Hudson River (Ordovicic) shales, thus showing a sharp contact between rocks of two great periods of earth history. The shale layers are more steeply inclined because they were affected by both the Taconic and Appalachian disturbances, while the conglomerate was affected only by the latter disturbance.

From N. Y. State Mus. Rep't 60 (2), 1906, pl. A, facing p. 298

sider that sedimentation was uninterrupted, though as a matter of fact there were certainly minor oscillations of level which inter-

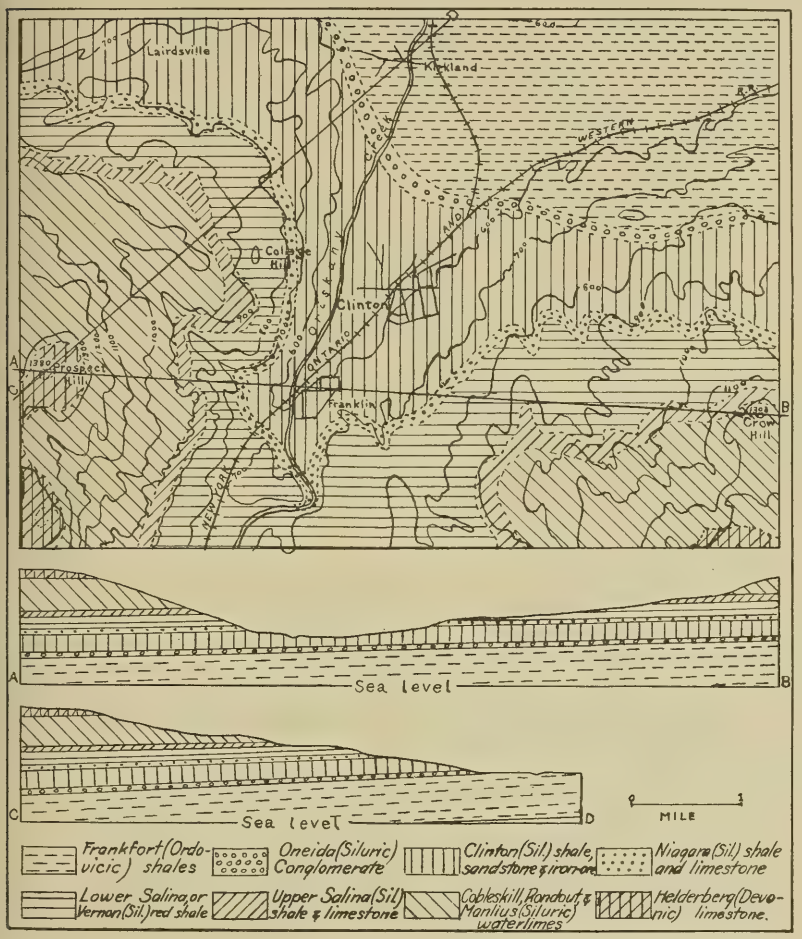


FIG. 17 Geologic and topographic map and structure sections of the vicinity of Clinton (Oneida county) showing the surface distribution and underground relations of the various rock formations from the Upper Ordovicic to the Lower Devonic inclusive. Note the simple nonfolded and nonfaulted structure, and the gentle southwesterly dip (tilt) of the formations. A similar simple structure characterizes the formations of the whole southwestern plateau province. Vertical scale of the sections four times exaggerated.

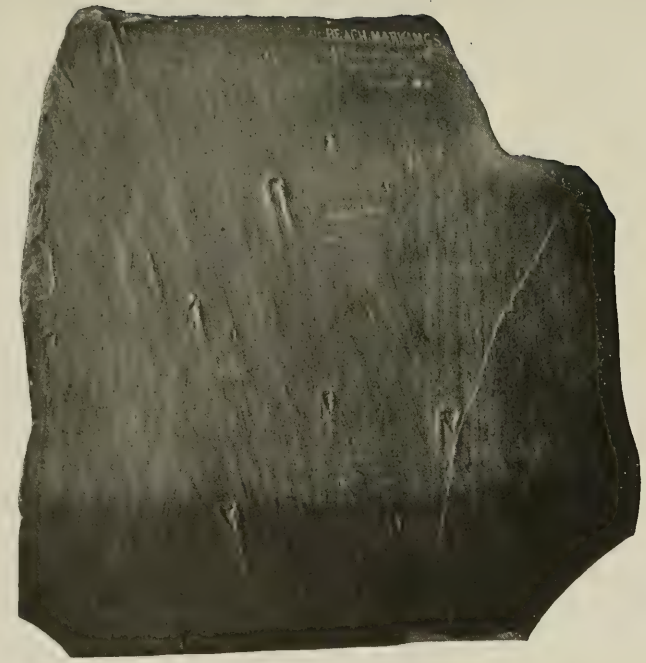
Geology by W. J. Miller

fered with the deposition of sediments and produced slight unconformities. These minor interruptions have not yet been carefully

studied and hence need not be considered here. The total thickness of Siluric strata along the line of outcrop in the State varies considerably. In central and western New York the thickness is generally from 1000 to 1500 feet, while in southeastern New York it is much less since only the thinned upper formations are present.

The first Siluric sediments to form in central and western New York are called the Oneida conglomerate and Medina sandstone, these two being of practically the same age. These coarse deposits were washed into the shallow sea from the northern lands, that is in Canada and the Adirondack region. Next in order came the deposits of Clinton age, which consist of layers of shale, sandstone and iron ore. Above the Clinton come the Lockport and Guelph formations made up of shales and dolomitic limestone, the limestone forming the crest of Niagara Falls. None of the formations, so far mentioned, extend to the Hudson valley, but with the opening of the great Salina epoch Siluric deposits for the first time reached to the Hudson valley region where the earliest rock to form was the Shawangunk conglomerate which rests upon the eroded Ordovicic shales at the summit of Shawangunk mountain. This rock is entirely confined to southeastern New York, while rocks of the same age in central and western New York are shales and limestones. In this latter region the lowermost (oldest) Salina formation is the Vernon red shale, usually from 100 to 300 feet thick, which, in the western part of the State, is overlain by the salt and gypsum beds. Deep wells have proved the presence of the salt beds under practically all the Southwestern plateau. The salt was deposited in great salt lagoons and the climate of the time must have been arid. With an influx of fresh water into the lagoons, the type of deposit changed, and the hydraulic limestone (water lime) beds were formed all the way across the State to the Hudson valley region. These water lime beds are quarried at many places along the line of outcrop across the State, but more especially in the famous Rosendale cement region (see plate 33). Next in order, and marking the summit of the Siluric, come the Cobleskill, Rondout, and Manlius limestones which, though not very thick, are remarkably persistent across the State.

As to the life of the Siluric seas it may be said that it is in effect the continued existence of the same organic groups that preceded in the waters of Ordovicic time, though some diminished, some increased and some new ones made their first appearance. Thus the graptolites and trilobites greatly diminished, while the echinoderms (star fishes) increased, and the brachiopods and mollusks held



Beach markings on Medina sandstone

Seaweed, Arthrophycus harlani, on Medina sandstone
From N. Y. State Mus. Bul. 19, pl. 45

Niagara river gorge below the Suspension bridge, as viewed from the Canadian side. Very distinctly stratified beds of lower Siluric (Medina, Clinton and Niagara) age are shown.

From N. Y. State Mus. Bul. 19, pl. 55

The eastern face of Shawangunk mountain, 2 miles south of Lake Mohonk, Ulster county. The light colored rock forming the summit of the ridge is the very resistant Shawangunk conglomerate which protects the soft underlying mass of Hudson River (Ordovicic) shales.

From N. Y. State Mus. Bul. 19, pl. 40

Plate 29

Awosting falls over Shawangunk conglomerate, Peterkill, near Lake Minnewaska, Ulster county

From N. Y. State Mus. Bul. 19, pl. 42

their own. Fossil seaweeds, but not animal remains, are common in the Oneida-Medina beds. Various fossils exist in profusion in the Clinton and Niagara formations, while in the middle Salina beds fossils are altogether absent because the water of that time was intensely saline. The waterlime beds at the base and top of the Salina are usually poor in fossils except for the remarkable assemblage of organic remains known as eurypterids which belonged to the arachnid class but are now wholly extinct. Fossils are generally rather common in the uppermost Siluric beds of the State.

DEVONIC AND CARBONIC PERIODS

The Devonic history of New York State is comparatively simple and the records are remarkably well shown in rocks of that age. *Devonic strata comprise the whole Catskill and Southwestern plateau provinces, except for a few small patches of Carbonic rocks, and thus cover more than one-third of the area of the State. They are more widespread on the surface than the rocks of any other age.* The combined thickness of the Devonic strata is over 4000 feet, which is considerably more than for any other Paleozoic period in the State.

That the Devonic strata, on the Hudson valley side, formerly extended some miles farther eastward than they now do is proved by the presence of small outliers of Devonic rock, for example, Becraft mountain just southeast of Hudson, the Rensselaer grit farther north and the Skunnemunk mountain southwest of Newburgh. During part of the time the Devonic sea, or arms of it, reached as far east as these outlying masses and doubtless far beyond over the regions of Massachusetts and the Connecticut valley. The bold outcropping edges of thick Devonic strata facing the Mohawk valley and, in the Helderberg escarpment, the Ontario plain, make it certain that the strata formerly extended some distance farther northward. It is more than likely that this northward extension of Devonic rocks was not beyond the southern border of the Adirondacks; at least we have no positive knowledge that the Devonic sea ever covered any of northern New York (see figure 18).

There was no disturbance of any kind at the close of the Siluric, so that period passed very quietly into the Devonic. The Oriskany sandstone was for many years regarded as the base of the Devonic but now, as a result of a careful study of the fossils, the line between Siluric and Devonic is drawn just below the Helderberg lime-

stone. As is the case with the Siluric, the rock formations are piled one upon another like great sheets and all show a gentle southward dip (see figures 3 and 5). Beginning at the bottom, the Helderberg limestone was succeeded in regular order by the Oriskany sandstone, Onondaga limestone, Marcellus and Hamilton

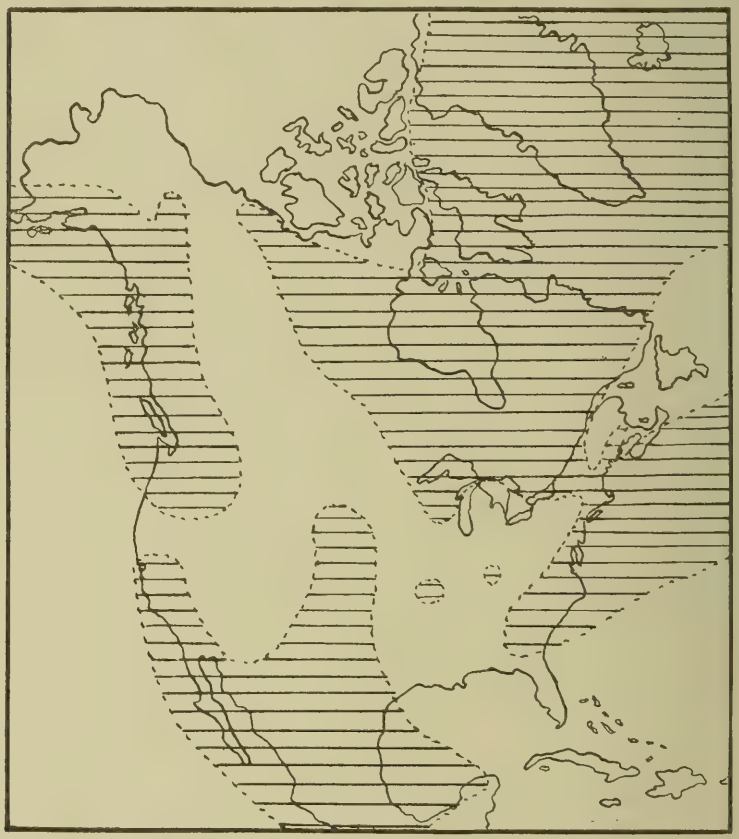


FIG. 18 Generalized map of North America in the Devonic period, showing the relations of land and water. Horizontal lined areas = land; blank areas = water. Only the northern and extreme southeastern portions of the New York State area were land. The western shore of Appalachia was farther west than during the Ordovicic, due to the addition of the Taconic mountain area

shales, all of which were deposited over the whole Devonic basin in New York. Above these come the Tully limestone and Genesee shale which extend from east-central to western New York. Still higher, and forming the summit of the Devonic, are the Portage shales and sandstones and the Chemung (or Catskill) sandstones

Plate 30

Cliff of Lower Devonic (Coeymans) limestone near Indian Ladder, Albany county

From N. Y. State Mus. Bul. 19, pl. 70

Marcellus and Hamilton (Devonic) shales outcropping along the shore of Lake Erie at Athol Springs, Erie county. The rock is dark colored and in thin layers. The smooth, vertical walls are due to a breaking off of rock masses along what are called "joint planes" and which are so common in nearly all rock ledges.

From N. Y. State Mus. Bul. 19, pl. 72

Upper Devonic (Cashaqua and Rhinestreet) shales in the gorge of the Genesee river near Mount Morris. The thin bedded and stratified character of these rocks are well shown.

From N. Y. State Mus. Bul. 118, pl. 4

which extend from the Catskill mountains to western New York.

Except for the comparatively thin Tully formation, the limestone is confined to the Lower Devonic and the lower part is not more than a few hundred feet thick. Thus the great bulk of Devonic rock lies above this limestone and consists of shales and sandstones piled layer upon layer. These latter rocks are clearly land-derived sediments which were washed into the Devonic sea by streams from the Taconics and also probably from land areas which are known to have existed to the north in Canada.

The Devonic strata, from oldest to youngest, abound in the fossils of marine organisms, and some fossil land plants have also been found. Looked upon in a broad way, Devonic life was much like that of the Siluric, though certain fundamental differences are to be noted. Thus the Devonic furnishes the first really authentic evidence of the existence of land plants. Such plants as ferns, lycopods (club mosses), and equisetae (horse tails) grew to be large treelike forms and in considerable profusion. Remains of these have been found in the Devonic strata in New York. All of them belonged to the very simple, nonflowering plants and were closely related to the plants of the next succeeding Carbonic (coal) period. Among the fossil animals especially abundant in the Devonic rocks of the State are: sponges, corals, echinoderms (star fishes), brachiopods, mollusks (including the bivalves, gastropods, and cephalopods), and arthropods (including trilobites and eurypterids). The graptolites became extinct during the early Devonic. One of the remarkable features of the life was the great abundance and variety of fishes, so that this period is commonly referred to as the "Age of Fishes." From the zoological standpoint all the fishes were of simple types, the true bony skeletons of modern fishes being entirely absent. Devonic fish remains in considerable numbers have been found in the State.

Carbonic strata are only very sparingly represented in New York, there being a few small outlying masses in the southwestern portion of the State (Cattaraugus and Allegany counties). Immediately southward, in Pennsylvania, Carbonic strata are developed on a great scale so we can be certain that the Carbonic sea spread over the southern border of New York State. It is quite possible that this sea extended over most of southern New York, but positive evidence, due to absence of strata, is lacking.

The Permic is the last great period of the Paleozoic era, but rocks of that age are nowhere present in New York State.

APPALACHIAN MOUNTAIN REVOLUTION (CLOSE OF THE PALEOZOIC)

The Paleozoic era was brought to a close by one of the most profound physical disturbances in the history of North America. It has been called the Appalachian revolution because at this time the Appalachian mountain range was born out of the sea by upheaval and folding of the strata. Because of the direct effect of this great upheaval upon the history of New York State, a brief description is given.

All through the vast time (probably ten million years) of the Paleozoic era, a great land mass existed along what is now the eastern coast of North America. This land, which has been called Appalachia, had its western boundary approximately along the present coast line, while it must have extended eastward at least as far as the present border of the continental shelf. Concerning the altitude and character of the topography of Appalachia we know almost nothing, but we do know that it consisted of metamorphic rock of Precambric age, and very similar to that of the Adirondacks. The tremendous amount of derived sediments shows that Appalachia was high enough during nearly all its history to undergo vigorous erosion. Although oscillations of level more than likely affected Appalachia, and its western shore line was quite certainly somewhat shifted at various times, nevertheless it persisted as a great land-mass with approximately the same position during all its long history. Its general position is well shown on the map, figure 16.

Barring certain minor oscillations of level, all the region just west of Appalachia was occupied by sea water during the whole Paleozoic era, and sediments derived from the erosion of Appalachia were laid down layer upon layer upon that sea bottom. The coarsest and greatest thickness of sediments was deposited nearest the land, that is along what we might call the marginal sea bottom. At the same time finer sediments, in thinner sheets, were being deposited all over the Mississippi valley region. By actual measurement, in the present Appalachians, we know that the maximum thickness of these sediments was at least 25,000 feet. These are all of comparatively shallow water origin, as proved by the coarseness of sediment, ripple marks, fossil coral reefs etc., and so we are forced to conclude that this marginal sea bottom gradually sank during the process of sedimentation, thus producing what is called a great geosynclinal trough. Perhaps the very weight of accumu-

lating sediments caused this sinking. Finally, toward the close of the Paleozoic era, sinking of the marginal sea bottom and deposition of sediments ceased, and "eventually the trough began to yield to lateral compression and its contained strata were thrown into folds or fractured by great overthrusts. Thus in place of a sinking sea bottom along the shore of the great interior sea, arose the Appalachian mountains, which in their youth may have been a very lofty range rivalling the Alps in height. This range extends from the mouth of the St Lawrence river to Alabama."[1] As a result of this great physical revolution practically all of eastern North America was raised well above sea level, though the more moderately elevated Mississippi valley region was unaccompanied by folding or faulting of the strata.

The effect of the Appalachian revolution upon New York State is of fundamental importance because the whole State, except probably a small area near the mouth of the present Hudson river, was raised well above the sea, and true marine conditions never again prevailed over any part of its area except the extreme southeastern portion.[2] Judging by the vast amount of erosion which took place during the succeeding Mesozoic era, we are safe in our belief that the general elevation of the State at the close of the Paleozoic was at least several thousand feet above sea level. It is also important to note that this great uplift in New York was accomplished without any folding of the strata except along the Hudson valley. The gentle southward to southwestward tilt (dip) of the Paleozoic strata, however, is thought to have been produced at this time due to somewhat greater uplift on the north.

Along the western side of the Hudson valley, folds produced at the time of the Appalachian revolution are plainly visible, though the folding of the rocks here was much less violent than in the Appalachians proper. As a matter of fact these folds are but continuations of those of eastern Pennsylvania, but the compressive force in southeastern New York was too weak to cause much disturbance. Professor Davis has aptly styled these, "Little mountains east of the Catskills." By far the most conspicuous physiographic feature of this folded region is the Shawangunk mountain (ridge) which stands out very prominently and whose

[1] Scott's Introduction to Geology, second edition, p. 647.

[2] The influx of tide waters along the eastern and northern borders of the State in the Quaternary period presents no exception to this statement because the conditions then were esturaine rather than marine.

very existence is due to the fact that, as a result of the folding and subsequent erosion, the great sheet of hard and resistant conglomerate has been left as a protective cap over the soft Hudson river (Ordovicic) shales (see figure 19). In the Rosendale cement region the effects of the folding are also evident (see figure 10 and plate 33). The folds in the Siluric and Devonic strata of Skunnemunk mountain were also produced at this time. Of course the whole lower Hudson valley was subjected to this mild compressive force but, since all the rocks older than the Siluric were already so greatly disturbed, it is often impossible to see the effects of the Appalachian disturbance. Thus we see that mountain-building forces have affected the rocks of the Highlands-of-the-Hudson at least three times (Precambric, Taconic revolution, and Appalachian revolution); Cambric and Ordovicic strata of the lower Hudson valley twice (Taconic and Appalachian revolutions); and the Siluric and Devonic strata but once (Appalachian revolution).

The extensive faulting or fracturing of the eastern Adirondack and Mohawk valley regions is a matter of no small importance in our discussion of the physical history of the State, because the present major topographic features of those regions are largely dependent upon the faulting. It is generally believed that much of this faulting occurred toward the close of the Paleozoic era, and most likely at the time of the Appalachian revolution, but since considerable faulting certainly occurred later than that time, it is thought best to discuss this whole subject toward the close of the next chapter.

FIG. 19 The main body of the mountain consists of a great thickness of folded Ordovicic (Hudson River) shales and sandstones which are capped by a comparatively thin, but very resistant layer of Shawangunk conglomerate.

After Darton N. Y. State Mus. Rep't 47, 1894, facingp. 540

Chapter 5

MESOZOIC HISTORY

TRIASSIC PERIOD

We have observed that as a result of the Appalachian revolution New York State was raised well above sea level and this was its condition at the opening of the Triassic period. The total absence of any Triassic strata of marine origin makes it quite certain that the continent extended farther eastward than it does today and if so, the old Paleozoic land mass called Appalachia still existed, though probably much diminished in height by this time. The absence of marine rocks, however, does not mean that no deposition of Triassic sediments occurred within the borders of the State, because a remarkable series of nonmarine strata which were accumulated along the Atlantic slope are, in part, shown in southeastern New York (Rockland county and Staten island).

These nonmarine strata are of Upper Triassic age, as told by the fossils, and their present distribution and mode of occurrence clearly show that they were deposited in a series of long troughlike depressions whose trend was parallel to that of the main axis of the Appalachian range. These troughs lay between the Appalachians proper and old Appalachia. The latter also was now partly made up of the greatly worn-down Taconics. The facts that these troughs are truly downwarps, and that they so perfectly follow the trend of the Appalachian folds, make it certain that they were formed by a great lateral pressure which was a continuation of the Appalachian disturbance. Thus the Appalachian mountains still seem to have been growing well into the Triassic period, and while the Paleozoic strata were being folded the surface of old Appalachia, including part of the Taconic region, was also more or less warped, and the downwarps formed the troughs in which the Triassic beds were deposited. One of these troughs extends along the Connecticut river through Connecticut and Massachusetts; another, and the largest, reaches from Rockland county, New York, through northern New Jersey, southeastern Pennsylvania, Maryland, and into northern Virginia; while several smaller ones lie in Virginia and North Carolina. These depressions were most favorably situated for rapid accumulation of thick deposits because of their position immediately between the two great land masses which

were being eroded. The sediments derived from the erosion of the young Appalachians were especially abundant because of the vigorous wearing down of the young mountains. A thickness of thousands of feet of nonmarine rocks, mostly red sandstones and shales, was finally accumulated in these basins, and is known as the Newark series. The great thickness of these rocks, from 10,000 to even possibly 15,000 feet, strongly argues for a gradual downwarping of the basins as deposition of sediments went on. It is often stated that these strata were formed in estuaries, but at least in the northern area, from the Connecticut valley to Maryland, many of the layers show sun cracks, rain-drop pits, ripple marks, and remains and footprints of land reptiles. These features show that for the most part the beds were formed in very shallow water such

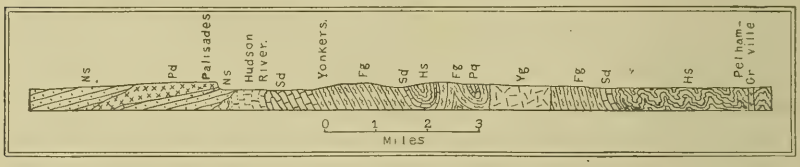


FIG. 20 Detailed section running west-northwest through Pelhamville, Yonkers and the Palisades in southeastern New York, showing the intense folding of Taconic age, the granite dikes, and the relation of the Palisade lava to the other formations. Fg = Fordham fineiss (Precambric); Pq = Poughquag quartzite (Cambric); Sd = Stockbridge dolomite (Cambro-Ordovicic); Hs = Hudson schist (Ordovicic); Yg = Yonkers gneiss; Gr = granite dike; Ns = Newark sandstone (Jura-Trias); Pd = Palisade diabase or lava (Triassic).

Modified from New York City folio, U. S. G. S.

as flood plains or lakes where changing conditions frequently allowed the surface layers to lie exposed to the sun.

During the time of the formation of the Newark beds there was considerable igneous activity as shown by the occurrence of sheets of igneous rocks within the mass of sediments. In some cases true lava flows, with cindery tops, were poured out on the surface and then became buried under later sediments, while in other cases the sheets of molten rock were forced up either between the strata or obliquely through them, thus proving their intrusive character. As a result of subsequent erosion, these lava intrusions often stand out conspicuously as topographic features. Perhaps the most noteworthy of these is the great igneous rock sheet, part of which outcrops to form the famous Palisades of the Hudson and which outcrops altogether for a distance of seventy miles. As shown in

Hydraulic limestone or waterlime of Salina (Siluric) age at the cement quarries 1 mile south of Whiteport, Ulster county. The pronounced tilt of the strata was given at the time of the Appalachian revolution.

From N. Y. State Mus. Bul. 19, pl. 116

Palisades-of-the-Hudson, as seen from Hastings, Westchester county. The rock is a sort of dark colored lava (diabase) which presents a crude columnar structure and rests upon sandstone of Triassic age. The sandstone is largely concealed by the rock debris just above the river level.

From N. Y. State Mus. Bul. 19, p. 4

figure 20, the molten rock sheet first broke through the strata and then crowded its way along parallel to them. During the process of cooling there was contraction which expressed itself by breaking the rock mass into great, crude, vertical columns, and hence the origin of the name "Palisades" (see plate 34). At the base of the Palisade rock, as well as on its top a little back from the edge of the cliff, the Newark sandstone outcrops. The steep cliff is due to the fact that the hard igneous rock is much more resistant to erosion and weathering than the sandstone above and below it.

The rocks of the Newark series are nearly everywhere somewhat folded, tilted and extensively fractured by normal faults. Just when this deformation occurred is not exactly known, but it was probably at the close of the Triassic period as will be shown under the next heading.

Briefly summarized, *the Triassic was a time of accumulation of thick deposits of red sandstone and shale of nonmarine character in troughlike depressions along the Atlantic slope, these deposits being represented in southeastern New York. During their formation there was considerable igneous activity when sheets of lava were forced through or between the strata as is well shown in the case of the rock of the Palisades.*

JURASSIC PERIOD

No rocks of Jurassic age occur within New York State nor as a matter of fact in all eastern North America, except possibly some fresh-water deposits along the Potomac river of Maryland. The failure of such strata is readily explained by the fact that the Jurassic period was ushered in by a slight upwarping (accompanied by faulting and tilting of the rocks) of the Atlantic border of North America so that there were no basins of deposition within the present eastern border of the continent. That this uplift actually occurred and that the Jurassic period in the eastern United States was a time of extensive erosion, is well established because the whole Atlantic seaboard, including the tilted and faulted Triassic strata, was worn down well toward the condition of a peneplain and the next sediments (Cretacic) were deposited upon the eastern portion of that worn-down surface (see figure 22). For instance, on Staten island and in northern New Jersey, the Cretacic beds may be seen resting directly upon the deeply eroded Triassic rocks, and hence the proof is conclusive that during much if not all of the Jurassic period active erosion was taking place, and this in turn implies that the Triassic beds were well elevated in the early Jurassic.

Briefly summarized: *No deposition of Jurassic strata occurred within the borders of New York State but instead, the region was well above water and undergoing active erosion so that by the close of the period this region, as well as the whole Atlantic slope, had been worn down to the condition of a fairly good peneplain.*

CRETACIC HISTORY

The Cretacic period opened with the eastern coast line of the eastern United States somewhat farther out than it now is, but early in that period there was enough subsidence, or possibly warp-

FIG. 21 Generalized map of North America in the Upper Cretacic period, showing the relations of land and water. Horizontal lined areas = land; blank areas = water. The sea then spread over the Atlantic coastal plain region including Long and Staten Islands of New York. During the next (Teritary) period, the conditions were much the same along the Atlantic and Gulf coasts, but in the west the great interior sea had disappeared.

ing, of the coastal lands to allow deposition of sediments over much of the region now known as the Atlantic Coastal plain. That but little downwarping of the surface was necessary in order to produce proper conditions for sedimentation is evident because the coastal lands, just prior to the Cretacic, were already low-lying as a result of the long Jurassic erosion period. There was just enough warping of these low coastal lands to produce wide flats, flood plains, shallow lakes, and marshes back from the real coast line and in which were deposited the sediments derived from the Piedmont plateau and Appalachian areas. The early Cretacic deposits thus formed are known as the Potomac series, and consist of very irregular layers of sand, gravel and clay. The very irregular arrangement of these beds and their rich content of fossil land plants, afford conclusive evidence that the sediments were not accumulated under marine conditions. The Potomac series outcrops at the western margin of the present Coastal plain and has been traced from Martha's Vineyard, through Nantucket, Long Island, Staten island, Northern New Jersey, and southward into Georgia. Passing seaward the strata dip under those of later age (see figure 22). On Long Island, Potomac outcrops occur only along the northwestern border but these beds no doubt dip under the more recent deposits of the rest of the island. The maximum thickness of the Potomac series is only about 700 feet.

Along the Atlantic coast certain deposits which should come between the Lower and Upper Cretacic are missing, and the Upper Cretacic beds rest upon the eroded surface of the otherwise undisturbed Lower Cretacic. Thus we know that there was a gentle upward oscillation of the land toward the end of the Lower, or beginning of the Upper, Cretacic, after which a moderate amount of erosion of the Lower Cretacic beds took place.

Then came another gentle submergence of the coastal lands when the Upper Cretacic strata were formed. The character and present extent of these deposits, and the fact that they are of marine origin, prove that this subsidence allowed a shallow sea to spread over practically all of what is now called the Atlantic Coastal plain including most of Long and Staten islands in New York. *Accordingly we learn that, for the first time since the close of the Paleozoic, did truly marine conditions prevail over any portion of New York State, and also that Appalachia, the great land mass of the east, which had persisted through the many million years of the Paleozoic and most of the Mesozoic, now disappeared under the Cretacic sea.*

The present surface distribution of the Upper Cretacic beds is much like that of the Lower Cretacic, and they also dip under the still later formations of the Coastal plain (see figure 22). The thickness of the Upper Cretacic is never more than a few hundred feet.

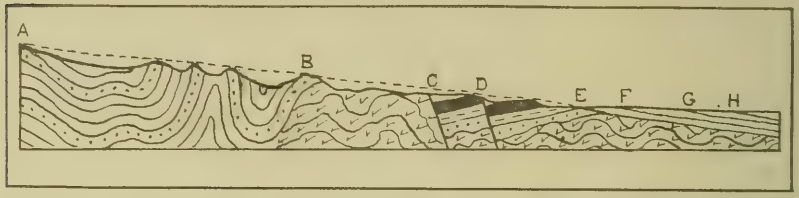


FIG. 22 Diagrammatic section through the Atlantic slope, at about the latitude of northern New Jersey, showing the structures and relations of the various physiographic provinces as they now exist.

A to B = Folded Paleozoic strata of the Appalachian mountains, with hard strata standing out to form the ridges.

B to C = Piedmont plateau consisting of highly folded and metamorphosed rocks of Precambrian and early Paleozoic ages.

C to E = Triassic strata showing tilting and faulting of the beds and mode of occurrence of an igneous rock sheet (D) which outcrops to form a low ridge.

E to H = Coastal plain, consisting of comparatively thin sheets of unconsolidated sediments.

E to F = Cretacic beds (upper and lower).

F to G = Tertiary beds.

G to H = Quaternary beds

H = Present coast line.

The dotted line represents the peneplain character of the surface (except for the tilting) at the close of the Cretacic period.

To summarize: *The Cretacic period opened with slight subsidence of the Coastal plain region, including southeastern New York, to produce low-lying flats upon which the nonmarine Potomac sediments were deposited. Then came a slight reelevation (accompanied by erosion) followed by subsidence of the Coastal plain region enough to allow encroachment of the shallow sea in which the Upper Cretaceous sediments were accumulated.*

LIFE OF THE MESOZOIC

The life of the Mesozoic is but scantily represented within New York State because rocks of that age are so poorly exposed. The Mesozoic era is commonly referred to as the "Age of Reptiles" because animals of that class then reached their culmination of

development. During this era the great dinosaur reptiles, the largest land animals that every lived, stalked the western plains. Some remains of smaller dinosaurs have been found in the Triassic beds of the Atlantic coast, one specimen lately having been discovered in the Newark beds along the lower Hudson. Reptilian tracks abound in the Newark strata. Mammals appeared in the early Mesozoic, but throughout the era they continued small and comparatively insignificant. The first birds and true bony fishes (teleosts) appeared in the later Mesozoic, but they are either absent or not important in the Mesozoic of the middle Atlantic coast. The invertebrate life of the era was in general very different from that of the Paleozoic, few types from the latter era having persisted, and by the end of the Mesozoic the invertebrates took on a decidedly modern aspect.

Among plants, those of the early era were still simple nonflowering kinds much like those of the Carbonic or "Coal age," while in the late Mesozoic flowering plants of very modern types, including many of our present forest trees, were prominently developed. The Cretacic beds of the Atlantic coast are rich in fossil plants.

THE CRETACIC PENEPLAIN AND ITS UPLIFT

During all the Mesozoic era most of the eastern portion of the United States was above water and undergoing erosion, so that, as a result of this very long period of wear, the region was reduced to the condition of a more or less perfect peneplain. It is known as the Cretacic peneplain because of its best development during the Cretacic period. This vast plain extended over the areas of the Appalachian mountains, Piedmont plateau, all New York State, the Berkshire hills, and the Green mountains. Its most perfect development was in the northern Appalachians, for example, from east-central Pennsylvania to Virginia, where hard and soft rocks alike had been so thoroughly cut down that no masses projected notably above the level of the low-lying plain.

Farther northward, however, over New York and western New England, its development was less perfect so that certain masses of harder rock stood out more or less prominently above the general level of the plain. In the central and eastern Adirondacks many low mountains of very resistant igneous rock rose above the peneplain surface. In a similar manner an occasional low mountain stood out in the Berkshire Hills region, and it seems probable that the hard Devonic sandstones of the Catskills also rose notably above the peneplain, though in the latter case positive proof has not been

given. Thus, *toward the end of the Mesozoic era all the area of New York State had been reduced to a vast, monotonous, featureless plain (peneplain) except for the mountain masses of very moderate elevation in the east-central Adirondack, and possibly also the Catskill, regions.* As Professor Berkey says: "The continent stood much lower than now. Portions that are now mountain tops and the crests of ridges were then constituent parts of the rock floor of the peneplain not much above sea level. This rock floor was probably thickly covered with alluvial deposits (flood plain) not very different in character from the alluvial matter of portions of the lower Mississippi valley of today. Upon such a surface the principal rivers of that time flowed, sluggishly meandering over alluvial sands and taking their courses toward the sea (the Atlantic) in large part free from influence by the underlying rock structure. The ridges and valleys, the hills, mountains and gorges of the present were not in existence, except potentially in the hidden differences of hardness of rock structure. Such conditions prevailed over a very large region, certainly all of the eastern portion of the United States."[1]

In the western part of the United States the Mesozoic era was brought to a close by what must take rank as one of the greatest mountain upheavals in the history of North America. This is known as the Rocky Mountain revolution because the great Rocky Mountain system was chiefly formed at this time. At the same time *in the eastern part of the United States the Mesozoic was closed by an important physical disturbance though on a far less grand scale than that of the west. This disturbance produced an upwarp of the vast Cretacic peneplain with maximum uplift of from two to three thousand feet following the general trend of the Appalachians and thence through northern New York.* This upward movement was unaccompanied by any renewed folding of the strata, and the effect was to produce a broad dome sloping eastward and westward, and northward to the Gulf of St Lawrence and southward to the Gulf of Mexico.

A prominent effect of this great uplift was to revive the activity of the streams so that they once more became active agents of erosion. *We are now prepared to make the important statement that the present major topographic features of New York State, as well as western New England and the whole Appalachian region, have largely been produced by the erosion or dissection of this up-*

[1] N. Y. State Mus. Bul. 146, p. 67.

Looking eastward down the valley of the west branch of the Susquehanna river from a point 2 miles west of Renovo, Clinton county, Pa. The river here cuts across a series of Appalachian ridges and the view was taken from near one of the summits. The remarkable concordance of altitudes or "even sky line" of the ridges is well shown and this uniform level of the ridge tops represents the surface of the upraised Cretacic peneplain.

Photo loaned by W. M. Gaylor, Sag Harbor, N. Y.

Precambric rock in the Highlands of the Hudson. Anthony's Nose and Manitou mountain along the Hudson river. The fairly even sky line of the mountain summits represents the old, upraised Cretacic peneplain.

From N. Y. State Mus. Bul. 19, pl. 8

raised Cretacic peneplain. This being the case, are any remnants of that upraised surface still left? In the affirmative answer to this inquiry we have the most positive evidence for the former existence of the Cretacic peneplain. We have said that the most perfect development of the peneplain was from central Pennsylvania to Virginia, and it is just here where we should expect to find the best remnants of that old surface. In this region the typical Appalachian ridges and valleys, which run parallel to the trend of the mountain range, are very well developed. These valleys are the trenches cut along the belts of soft rock and to below the surface of the upraised peneplain, while the ridges have developed along the belts of hard rock and their summits actually represent portions of the old peneplain surface. These ridges all rise to the same general level for miles around, and as viewed from the summit of any one of them the concordant altitudes give rise to what is called the "even sky line" which is a most striking feature of the landscape. Plate 35 gives an excellent idea of the even sky line across these ridges.

In New York State the concordant altitudes are not so well shown both because the peneplain was here not so perfectly developed and because the attitude of the strata has largely been unfavorable to the formation of long, distinct ridges. Remnants of the peneplain are, however, unmistakably present in New York as, for example, on a very large scale over the great Southwestern plateau whose high points nearly always rise to altitudes of about 2000 feet. This plateau is simply a part of the upraised and dissected Cretacic peneplain, and the slight downward sag toward the middle (already noted in chapter 2) is no doubt due to a slight downwarping of the general level during the process of uplift. The topographic map (plate 4) well illustrates the character of this dissected plateau. The present elevation of the peneplain remnants does not necessarily indicate the maximum amount of uplift. In the next chapter evidence will be presented to show that, for the New York area at least, the land was considerably higher in the Tertiary period than it is at present.

The summit of the Tug Hill province is a small plateau at an altitude of about 2000 feet, and is merely a remnant of the upraised peneplain which was formerly connected with the Southwestern plateau. As one stands at the summit of Tug hill and looks out over the western slope of the Adirondacks, he is impressed by the remarkably even sky line there shown at an altitude of a little over 2000 feet. The east-central Adirondacks and the Catskills present exceptions because these regions stood out above the old peneplain.

The Mohawk and upper Hudson valleys have been so broadly and deeply trenched through soft strata that in them no remnants of the peneplain surface remain. Immediately eastward in the Berkshires, however, the old surface is well exhibited. In the Highlands-of-the-Hudson, a view from one of the high points shows a rather even sky line at an altitude of from 1200 to 1500 feet, the somewhat lower elevation of the old surface here being due to the fact that this region was east of the main axis of uplift.

Since the actual work of erosion or dissection of the upraised peneplain occurred during the Cenozoic era, further discussion of the subject is reserved for the next chapter. It has been the present purpose to prove that the Cretacic peneplain actually existed and that it was upraised.

FAULTING OF THE EASTERN ADIRONDACKS

The eastern and southern Adirondack regions have been extensively fractured or faulted (see figures *23 and 24*). *In fact the major topographic features of those regions such as the numerous north-northeast by south-southwest ridges and valleys are largely*

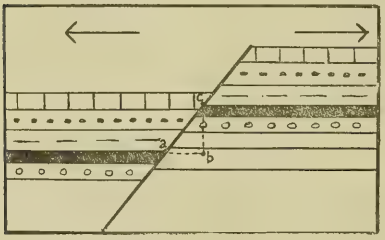


FIG. 23 Cross-section of a normal fault.

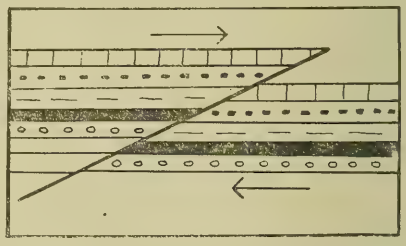


FIG. 24 Cross-section of a reversed or thrust fault.

dependent upon this faulted structure. These fractures are all of the normal fault type with fault surfaces practically vertical. Examination of the topographic maps of the whole eastern and southern Adirondacks shows that by far most of the ridges and valleys, streams and lakes trend in a north-northeast by south-southwest direction, or perfectly parallel to the direction of the major faults. Up to the present, no single fault has been proved to extend across the entire region, but rather there is a series of numerous parallel faults, no one of which has been traced much over 20 or 30 miles. The exact amount of displacement along these lines of fracture in the ancient crystalline rocks can not be determined, but many times it amounts to at least 2000 feet.

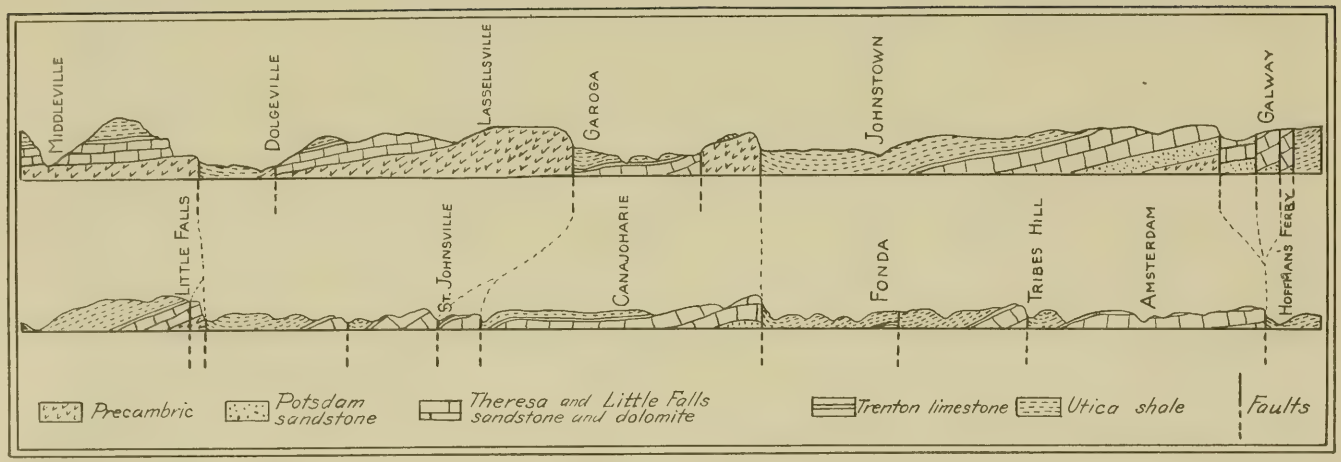


FIG. 25 Cross-sections of Mohawk valley faults. Lower section along the Mohawk river; upper section along a zone from 8 to 10 miles farther north. Length of each section 52 miles; vertical scale greatly exaggerated.

Modified after Darton, Annual Rep't N. Y. State Geol., 1894

This series of faults cuts through the early Paleozoic strata along the shores of Lake Champlain and in the Mohawk valley, and in these regions, due to marked differences in the rocks affected, it has been possible to determine carefully the character of the faults and the amounts of the displacements (see plate 37). Figure 25 shows two sections through the faulted region of the Mohawk

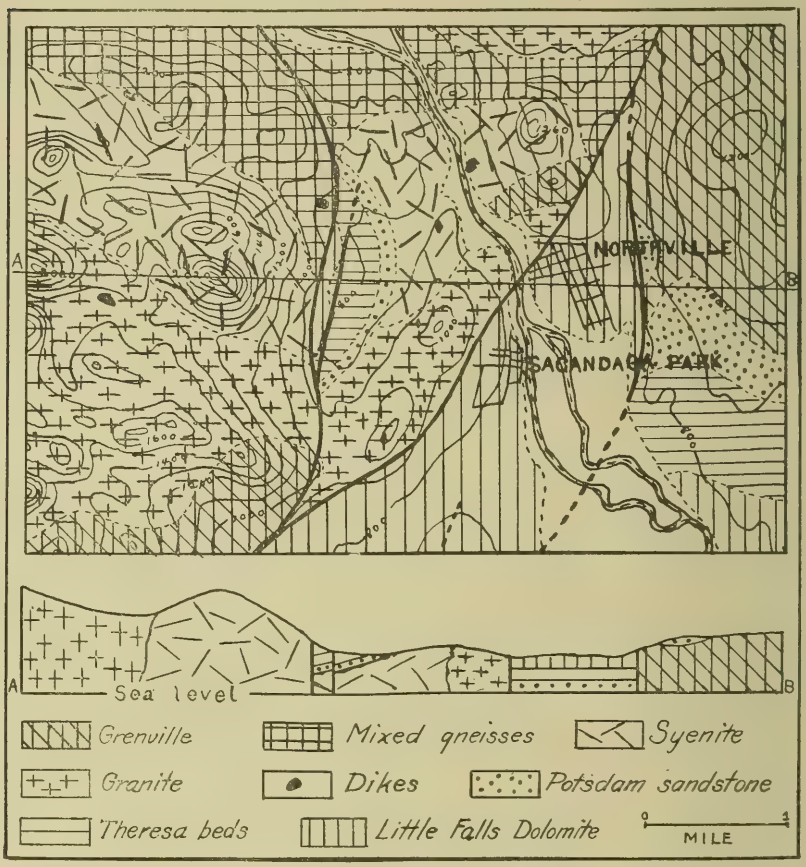


FIG. 26 Geologic and topographic map of the vicinity of Northville (Fulton county), showing an unusual variety of rock formations and structures along the southern border of the Adirondacks where the Precambric and Paleozoic rocks come together, and where all have been greatly faulted. The position of the structure section is indicated by the line AB, the vertical scale of the section being twice exaggerated. The greatest fault is the one on the west, and the country immediately on the east side of it has dropped fully 1500 feet with respect to that on the west (mountain) side. Northville lies between two smaller faults and on an earth block which has dropped several hundred feet with respect to the country on either side.

Geology by W. J. Miller, N. Y. State Mus. Bul. 153

Normal fault in bank of East Canada creek near Manheim, Herkimer county. The heavy beds on the left are Little Falls dolomite and the thin beds on the left are Trenton limestone. The steep tilt of the Trenton strata was caused by friction producing a sort of up-drag effect, during the slipping of the rock masses. The hole is artificial.

From N. Y. State Geol. Rep't 1894, pl. 4, facing p. 4

valley. To a considerable degree the topography of the valley is affected by the faults, especially where the harder Precambric or Cambric rocks form the scarp or upthrow sides of the faults. This is particularly true at Little Falls and the "Noses" (near Yosts) where, in each case, the Mohawk river has cut a gorge across a prominent fault scarp and even down to the underlying Precambric rock which has been brought relatively nearer the surface by the tilting of the earth blocks (see figure 7). On the geologic map of the State (figure 1) two tongues of Paleozoic rock are seen to extend northward well into the Precambric rock area, and these are to be explained by the fact that, due to faulting along the west sides, the Paleozoic strata, for fifteen or twenty miles, have dropped down (relatively) fully 1500 feet with respect to the Precambric rock. The much more resistant Precambric rock has stood out against erosion and in each case rises with steep front from 1000 to 1500 feet above the Paleozoic rock surface (see figure 26). The small remnant of Paleozoic strata already referred to at Wells in Hamilton county was dropped down fully 2000 feet by faulting against the Precambric rock just west, and thus this remarkable Paleozoic outlier has been preserved from complete removal by erosion.

What is the age of the faulting or, in other words, when were these fractures developed? That some faulting, at least, occurred during Precambric time has been well established but, so far as known, those faults are of very minor importance, certainly having no appreciable influence upon the existing topography.

During the Paleozoic era, however, there is good reason to think that considerable faulting took place. At just what time during the era the faulting occurred is not now altogether certain, but it is certain that it was sometime after the deposition of the Ordovicic sediments because at many places those rocks are involved in the faulting. Cushing has suggested that the faulting may have been initiated at the time of the Taconic revolution when the rocks of the region immediately eastward were so greatly disturbed, but he says, "the great earth disturbances (Appalachian revolution) which prevailed in the Appalachian zone toward the close of the Paleozoic would seem more likely to have brought about the major faulting of the reigon."[1] At this latter time the rocks of northern New York were not folded but, as we have learned, the whole State was notably elevated, and during this disturbance conditions were cer-

[1] N. Y. State Mus. Bul. 95, p. 405.

tainly favorable for extensive fracturing of the strata. The disturbance of the early Mesozoic, which caused the fracturing of the Newark (Triassic) rocks along the Atlantic slope, quite certainly did not affect the Adirondacks because those faults are of a different type and closely confined to the Triassic basins.

If the major faulting occurred at the close of the Paleozoic, then the Mesozoic must have opened with the northeastern portion of the newly upraised New York State area cut by a great series of faults which caused the edges of the upturned earth blocks to stand out prominently as ridges. However this may have been, we are certain that by the close of the long period of Mesozoic erosion the old fault scarps or ridges were practically obliterated. If so, how do we account for the present Adirondack ridges which follow the fault lines? As a result of the uplift of the Cretacic peneplain one or both of the following things happened, either there was renewed faulting, or that as a result of unequal erosion (due to differences in rock character) on opposite sides of the faults, the old fault scarps were renewed. It is quite certain that both things occurred, and thus the surface of the newly elevated Cretacic peneplain in northeastern New York was made irregular by freshly formed fault scarps. This, together with the later (Cenozoic) erosion along the old fault lines and belts of weaker rocks, accounts for the existing Adirondack ridges. That some of the faulting actually dates from this time, or possibly even later, is proved by the present existence of certain steep fault cliffs in perfectly homogeneous rock masses, and by the fault blocks which have been scarcely modified by erosion since their formation.

DRAINAGE OF NEW YORK IN THE MESOZOIC

Thus far we have said very little about the early drainage features of New York State. In fact we must admit that prior to the Cenozoic era, we have practically no knowledge concerning the positions of even the major drainage lines of the State. From our knowledge of the land and water relations during the Paleozoic era, we can form only the most general ideas regarding the drainage. The Mesozoic physiography of the State is better known and hence the drainage is perhaps better known, but even here positive knowledge is almost wholly lacking. The whole subject of the Precenozoic drainage of New York is one which demands thorough study before anything like satisfactory conclusions can be reached, and the following very brief discussion is intended to be merely suggestive of the problems involved.

At the close of the Paleozoic, and as a result of the Appalachian uplift, the region of New York State was raised well above sea level, with the greatest uplift toward the north as shown by the general south to southwesterly dip (tilt) of the Paleozoic strata (see figures 3 and 5). At that time those strata lapped over much of what is now the Precambric rock area of the Adirondacks. The Appalachian folds of the Hudson valley region, as well as the highlands (of earlier origin) in general along the eastern border of the State, must have prevented any important eastward drainage. Thus, in the writer's belief, the strongest evidence suggests that the principal streams of the early Mesozoic era flowed in general southwesterly courses upon the surface of the newly upraised Paleozoic strata and away from the highlands of the eastern border of the State.[1]

If this be the correct interpretation (for others are certainly possible) of the early Mesozoic drainage, it must follow that no river at all comparable in length and position to the present Hudson could have existed along the eastern side of the State, and no large rivers, like the Susquehanna and Delaware, then had southeasterly courses across the Appalachian mountains.

During the long Mesozoic era, the area of the State was profoundly eroded, as already proved. In the midst of this era the ruggedness of Mesozoic relief reached its maximum and, in accordance with well-known principles, the valleys must have formed along the belts of softer rock, while the harder rocks stood out to form the highlands or ridges. At this time the edges of the Paleozoic strata had sufficiently retreated (by erosion) on all sides from the central Adirondacks so that a considerable area of Precambric rocks had already become exposed in northern New York. During this retreat of the Paleozoic strata there was a tendency to form important valleys, especially along the western and southern borders of the Adirondacks, because whenever the harder rock formations were encountered they would stand out as escarpments, while the softer rocks would be worn down into valleys. It is in accordance with these principles that the Mohawk and Black river valleys were formed, though it does not necessarily follow that these older valleys occupied the same positions as the present ones because of the gradual retreat of these depressions away from the Adirondack region.

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[1] It should be stated that the Great Lakes were not then in existence, those bodies of water not having been formed till late in the Cenozoic era (see chapter 6).

In western New York and over the region of the present Lake Ontario, the hard and soft early Paleozoic strata outcropped along a nearly east and west direction, and hence considerable streams, tributary to the major southwestward flowing streams, doubtless followed the belts of soft (shale) rocks. Such a west-flowing stream may have followed the belt of weak Ordovicic shales which runs under the present Lake Ontario.

In southeastern New York, in the midst of the Mesozoic era, the land was lower than at the beginning of the era as shown by the fact that the late Cretacic sea spread over at least some of the region. This gave a better opportunity for the development of an eastward or southward drainage toward the Atlantic basin, and at this time it is possible that the ancestors of the modern Hudson, Delaware, and Susquehanna rivers were formed.

However uncertain our ideas may be regarding the topography and drainage of the early and middle Mesozoic, we are nevertheless sure that by the close of the period the topography of the State was that of almost a peneplain which has already been described, and that the streams were all of low gradient and very sluggish. During the long erosion time of the Mesozoic, there must have been many changes in stream courses and adjustments to rock structures. By the close of the era the courses of the rivers are, as yet, not definitely known, though in accordance with the above discussion we are reasonably certain that the principal drainage of the State from the northern, central, and western portions was southwestward to westward into the Mississippi basin, while the drainage of the southeastern portion was southward to southeastward into the Atlantic basin.

Chapter 6

CENOZOIC HISTORY

TERTIARY PERIOD

Rock formations and life of the Tertiary The Mesozoic closed and the Cenozoic opened with the uplift of the great Cretacic peneplain. Before the uplift, the sea spread over the Long and Staten Islands region, but for a time after the uplift the land was there high enough to exclude the sea and New York State was wholly above sea level. This we know because the lowest (earliest) Tertiary deposits do not occur on Long or Staten Islands or in northern New Jersey, and hence the region must have been above water. The subdivisions of the Tertiary, from oldest to youngest, are known as Eocene, Miocene, and Pliocene. The early Eocene deposits are missing from the northern Atlantic Coastal plain, and on Long and Staten Islands we have no evidence that any of the Eocene is present which thus leads to the conclusion that all southeastern New York was dry land during the whole of the Eocene. During the Miocene there was enough sinking to allow the sea to encroach over the Long and Staten Islands districts as well as the whole northern Coastal plain. Except for very slight oscillations of level which we shall here disregard, the region remained submerged under shallow sea water during all the Miocene and Pliocene, or till the close of the Tertiary period. The Tertiary deposits were sands, gravels, and clays which formed layer upon layer in the shallow sea along the margin of the continent (see figure 22), but on Long and Staten Islands they are seldom seen because of the more recent covering of glacial deposits. They are finely exposed in the Coastal plain of New Jersey.

The Tertiary period is generally called the "Age of Mammals" because, although mammals began in a small way in the Mesozoic, they became the dominant feature of life for the first time in the Tertiary. In the early Tertiary the mammals were very different in appearance from those of the present, a common form then being a generalized or ancestral type (for example, Phenacodus) about the size of a dog and having five toes. Many of our modern mammals have descended from this type. During the Tertiary the mammals developed very rapidly so that by the close of the period they were very much as they are today except that man, the highest

and most wonderful animal of all, did not appear until the last (Quaternary) period of earth history. Birds developed to much like their present forms. Reptiles diminished both in size and number of species in a remarkable way, while fishes took on a decidedly modern aspect. The invertebrates of the Tertiary were not strikingly different from those of the present and by the close of the period they were so modern that from 75 to 90 per cent of them were even the same species as those now living.

We learned that, in the late Mesozoic, true flowering plants had been developed in abundance, and during the Tertiary these and all other plants reached a development which in no essential way was different from that of the present.

The records of Tertiary life are but scantily represented in New York because of the small extent of exposed Tertiary rocks. In the deposits of the Atlantic Coastal plain, however, abundant fossils are found.

Development of relief features. The uplift of the great Cretacic peneplain was an event of prime importance for New York because it literally furnishes us with the beginning of the history of most of the existing relief features of the State. Hence we assert with emphasis that all the principal topographic features of the State as we see them today date from the uplift of the Cretacic peneplain because they have been produced by the dissection of that upraised surface. This dissection was largely the work of erosion, though in the eastern Adirondack region faulting has produced notable effects. All the great valleys such as the Champlain, St Lawrence, Black river, Mohawk, and Hudson have been produced since the uplift of the peneplain. It should also be stated that the Great Lakes, as well as the numerous lakes, gorges, and waterfalls for which New York is noted, were absent as geographic features at the opening of the Cenozoic.

As previously stated, the streams of New York which flowed upon the peneplain surface sluggishly meandered over deep alluvial or flood-plain deposits, and their courses were little if any determined by the character of the underlying rocks because hard and soft rocks alike were worn down to a general level. The uplift of the peneplain, however, greatly revived the activity of the streams so that they became very effective agents of erosion; they first cut channels through the alluvial deposits and then into the underlying bedrock. Thus these large original streams had their courses determined in the overlying deposits, and when the underlying rocks were reached the same courses had to be pursued

entirely without reference to the underlying rock character and structures. Such streams are said to be superimposed because they have, so to speak, been let down upon the underlying rock masses. To quote Professor Berkey: "The larger rivers, the great master streams, of the superimposed drainage system, in some cases were so efficient in the corrasion of their channels that the discovery of discordant structures (in the underlying rocks) has not been of sufficient influence to displace them, or reverse them, or even to shift them very far from their original direct course to the sea. They cut directly across mountain ridges because they flowed over the plain out of which these ridges have been carved and because their own erosive and transporting power have exceeded those of any of their tributaries or neighbors."[1] Fine examples of such superimposed streams which are now entirely out of harmony with the structure of the regions over which they flow are the Susquehanna, Delaware, and Hudson. Thus the Susquehanna cuts across a whole succession of Appalachian ridges while, in accordance with the same explanation, the Delaware cuts through the Kittatinny range at the famous Delaware Water Gap. The lower Hudson pursues a course no less out of harmony with the structure of the country through which it passes. Thus it flows at a considerable angle across the Taconic folds above the Highlands, after which it passes through a deep gorge which it has cut through the hard granites and other rocks of the Highlands. The simple explanation is that the Hudson had its course determined upon the surface of the upraised Cretacic peneplain, and that it has been able to keep that course in spite of the discordant structures of the underlying rocks.

But while the great master streams were thus cutting deep trenches in hard and soft rock alike, numerous side streams or tributaries came into existence and naturally developed along the belts of weak rock and in harmony with the geologic structures. This is true of all the streams now occupying the valleys between the Appalachian ridges. In southeastern New York two remarkable cases are presented by the Wallkill river and Rondout creek which flow many miles northeastwardly and in a direction almost the reverse of that of the Hudson to which they are tributary. As the master superimposed Hudson cut its channel deeper and deeper, the Wallkill and Rondout side streams were enabled to cut their valleys deeper and deeper while they increased in length by pushing

[1] N. Y. State Mus. Bul. 146, p. 69.

their headwaters farther southward, but only along belts of weak rock and in harmony with the northeast-southwest folded structure of the region.

In a similar manner the great Mohawk valley has been developed. The Mohawk is the chief tributary of the Hudson, and whether or not its ancestor flowed in about the same position upon the surface of the peneplain, we do know that the present Mohawk valley (below Little Falls) has been carved out of the upraised peneplain by the Mohawk river and its tributaries along a belt of weak Ordovicic shales. The valley is bounded on the north by the very hard Precambric rocks and on the south by the fairly resistant limestones of the Helderberg escarpment. Proof will be given on a later page for the statement that late in the Tertiary (that is just prior to the great Ice age) the Mohawk river had its source near Little Falls, and that at the same time another stream (Rome river), now extinct, flowed westward from Little Falls, past Utica and Rome and into the basin now occupied by Lake Ontario. West Canada creek was then tributary to the Rome river, while the Sacandaga river flowed into the Mohawk instead of the Hudson as it now does.

However uncertain we may be as to the location of a Precenozoic Susquehanna river, we are very certain that the present numerous, deep channels of the Susquehanna drainage system have been cut into the upraised peneplain. The Susquehanna, like the Hudson, is a good example of a superimposed stream and its ancestor may have flowed along the same general course over the low-lying peneplain before its uplift. Immediately after the uplift some of the more easterly headwaters of the Susquehanna came out of the southern Adirondacks. Evidences of this are as follows: (1) The present Mohawk valley had not been formed, the Mohawk river then having only begun the westward migration of its headwaters along the belt of soft shales; (2) the natural slope of the southern Adirondack region was then southward into the east branches of the upper Susquehanna; and (3) the positions of the present sources of the east branches of the Susquehanna at the crest of the high Helderberg escarpment, and in some cases within a very few miles of the present Mohawk river (see drainage map, figure 11) strongly argue for the cutting off or beheading of the former headwaters of the east branches. This beheading was accomplished by the Mohawk as its headwaters migrated slowly westward thus tapping one by one of the upper waters of the east branches of the Susquehanna. Even today the Mohawk continues to steal drainage

territory at the expense of the Susquehanna because the short, swift tributaries of the Mohawk, which flow northward over the Helderberg escarpment, are cutting down their channels rapidly, while their headwaters are migrating southward into the territory of the Susquehanna. A great network of large and small streams tributary to the upper Susquehanna drain a considerable portion of south-central New York, there being no single great master stream in this region because the rock formations are so nearly horizontal and are so much alike as regards resistance to erosion.

The Delaware system has had a history practically the same as that of the Susquehanna, except that it never drained any of the region north of the Mohawk.

The present ruggedness of the Catskills is largely, if not altogether, due to the production of deep channels which have been cut into the region upraised at the time of the uplift of the great peneplain by the headwaters of the Delaware, Schoharie creek (north-flowing), and the smaller streams flowing across the steep eastern front of the mountains.

During Tertiary times Lake Champlain was certainly not in existence, but the great depression was there and was no doubt largely developed or at least increased in depth by the settling of earth blocks during the time of extensive faulting at the close of the Mesozoic or beginning of the Cenozoic. The depression is essentially a fault trough. The major stream occupying this valley flowed northward and in late Tertiary time, at least, the divide between the drainage of this and the Hudson valley passed between Glens Falls and Whitehall, and through the present position of the "Narrows" of Lake George, the lake, of course, not then being in existence.

Drainage of New York in the Tertiary. The outline of the probable drainage condition of western New York during the Mesozoic has already been given, and now as we attempt to restore the drainage conditions of the Tertiary, we must admit that some problems yet remain unsolved. Lakes Ontario and Erie certainly were not in existence. Streams flowed through these basins, which were not as deep as they now are. The bottom of Ontario is as much as 491 feet below sea level, while its surface lies at an altitude of 247 feet, and the altitude of Erie is 573 feet while its greatest depth is 204 feet. The explanation of the increased depths of the basins is given on a later page. The question now arises, Did the waters from western New York drain westward or southwestward and into the Mississippi, or northeastward through the St

Lawrence? According to J. W. Spencer, the St Lawrence received those waters, but in the light of what we have said about Mesozoic drainage, and also in view of the fact that the St Lawrence now, in the Thousand Islands region, does not flow through anything like a distinct channel (see plate 9) cut out by a great river, we must admit that there is little to favor such northeastward drainage from western New York. The St Lawrence is almost certainly postglacial in its course at the Thousand Islands as shown by the lack of any real channel, and by the presence of a belt of hard Precambric rock extending across the river and connecting the Adirondacks with the Canadian Precambric rocks. This hard rock belt must have formed a preglacial divide until the recent formation of Lake Ontario and the downwarping of the land which allowed the drainage to pass over the divide for the first time (see later page).

Grabau's interpretation is that the Tertiary drainage of western New York passed westward and southwestward into the Mississippi, and this view is, in the writer's belief, far more tenable. The accompanying map (figure 27) gives a good idea of the drainage lines according to this view. The major drainage lines were no doubt inherited from the Mesozoic, the southwestward courses having been originally determined by the tilt of the land at the time of the Appalachian uplift. When the Cretacic peneplain was upraised, these major streams as, for example, the Dundas river, again began very active work of erosion, and tributary streams were developed, during the Tertiary, along the belts of weak rocks. Thus an important west-flowing tributary was developed along the belt of soft Ordovicic and Medina shales, and formed a channel where the basin of Lake Ontario now is. The Rome river, with source at Little Falls, became a branch of this stream while another important branch had its source on the Thousand Islands divide. There is also shown the position of the Black river, which by late Tertiary had already carved out that important valley and flowed into the Ontario depression, according to Grabau. More recent evidence, however (see later page), strongly favors the passage of the lower end of the Black river north and northeastward into the precursor of the modern St Lawrence, and which had its source on the Thousand Islands divide.

On the accompanying map the three south-flowing streams, one heading near Rochester and the other two flowing through Lakes Seneca and Cayuga, are, in the writer's judgment, not properly shown for the late Tertiary, that is, just prior to the great Ice age.

It is practically certain that preglacial streams were here north-flowing rather than south-flowing, because during long Tertiary time such tributaries to the large stream in the Ontario basin must have developed across the steep north slopes of the Niagara and Helderberg escarpments, and also because the slope of the Genesee

FIG. 27 Grabau's interpretation of late Tertiary drainage in the eastern Great Lakes region, the intention being to show the general kind of drainage rather than the exact location of the streams. The "Rome" river with source at Little Falls is well shown. The three south-flowing streams should, in the writer's opinion, be represented as north-flowing, at least immediately prior to the great Ice Age.

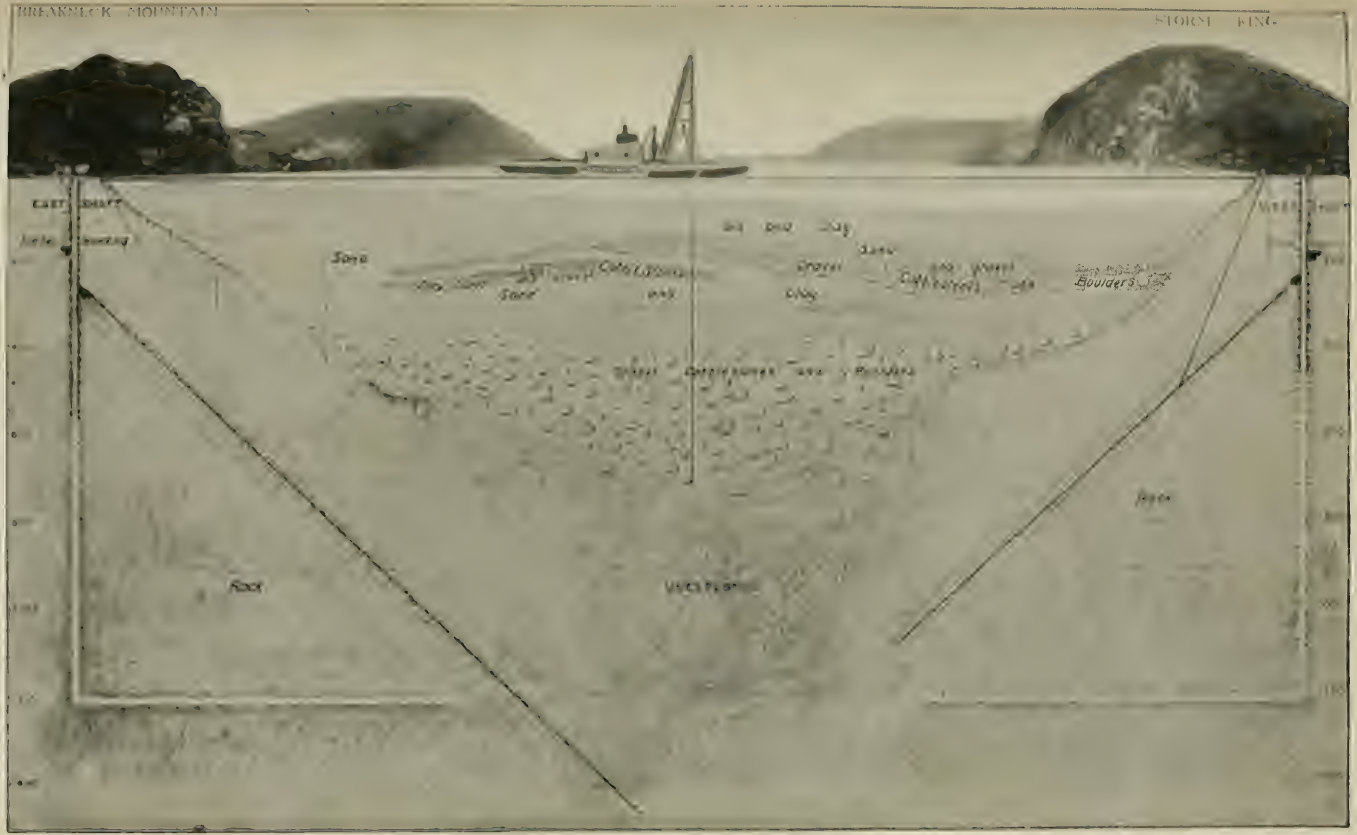
After Grabau, N. Y. State M s. B. l. 45, fig. 6

river is now, at least, so decidedly downward toward the north. If the late Tertiary Genesee flowed southward, the reversal of its course must have been caused by a very marked tilting of the land, but we have no evidence for such a decided land movement.

In our discussion of Mesozoic drainage (see chapter 5) we found that, during the early part of that era, nearly all the drainage of

the state passed southwestward to westward into the Mississippi valley with very little, if any, drainage into the Atlantic. But by the close of the Mesozoic, or the beginning of the Tertiary, a considerable south to southeastward drainage had been established along the lines of the Hudson, Susquehanna, and Delaware rivers. Have we any explanation for the establishment of these important drainages into the Atlantic? One view is that the courses came about as a result of the meandering and changing of channels on the surface of the low-lying Cretacic peneplain, and that these courses were maintained upon the upraised peneplain. Another view which the writer would suggest as worthy of consideration is that the south and southeasterly drainage lines were established as a result of the uplift of the peneplain. Chapter 5 shows that the axis of greatest uplift passed through northern New York from central Pennsylvania, the region of southeastern New York and northern New Jersey not being raised so high. It is very reasonable, if not highly probable, that this very warping or slow arching up of the peneplain surface inaugurated the present drainage toward the Atlantic because the streams, no matter what their previous courses, then naturally must have flowed down that initial slope toward the Atlantic.

After the uplift of the peneplain the larger streams cut down their channels most rapidly and would be the first to reach "grade," that is, a condition in which, because of low velocity, they could no longer cut down their channels, though the widening process could continue because of side cutting due to meandering of the streams back and forth from one side to the other of the channels. The deep but broad-bottomed, stream-cut valleys so common in New York State show that many of the streams had reached a graded or nearly graded condition even by the close of the Tertiary. In southeastern New York, at least, we have evidence to show that after the streams had reached grade there was an appreciable renewed uplift of the land which again revived the activity of the streams. Thus the broad Hudson valley, with minor hills rising above its surface, was produced when the Hudson was well along toward a graded condition and then, as a result of this late Tertiary uplift of the land, the present narrow and fairly deep inner channel (gorge) of the Hudson was formed. The Hudson did not reach grade in this inner channel, its work having been interrupted by the spreading of the great ice sheet over the region. It is not known



A composite diagrammatic cross-section of the Hudson gorge at the entrance to the Highlands-of-the-Hudson between Storm King and Breakneck mountains. The shaft and tunnel (at a depth of 1200 feet) show the position of the New York City aqueduct. The bottom of the old Hudson channel is seen to be deeply buried under clay, sand, gravel and boulders. The center boring has penetrated more than 700 feet without striking the old rock bottom. The depth of the rock channel here is more than 2000 feet or from the top of Storm King to the bottom of the buried channel. From N. Y. State Mus. Bul. 146, pl. 14

that this late Tertiary reelevation notably affected the rest of the State.

This inner gorge of the Hudson valley has been traced for fully 100 miles eastward beyond the mouth of the present river. The Coast and Geodetic Survey has made a detailed map (see figure 28) of the ocean bottom near New York City, and the submerged channel of the Hudson river is clearly shown as a distinct trench cut

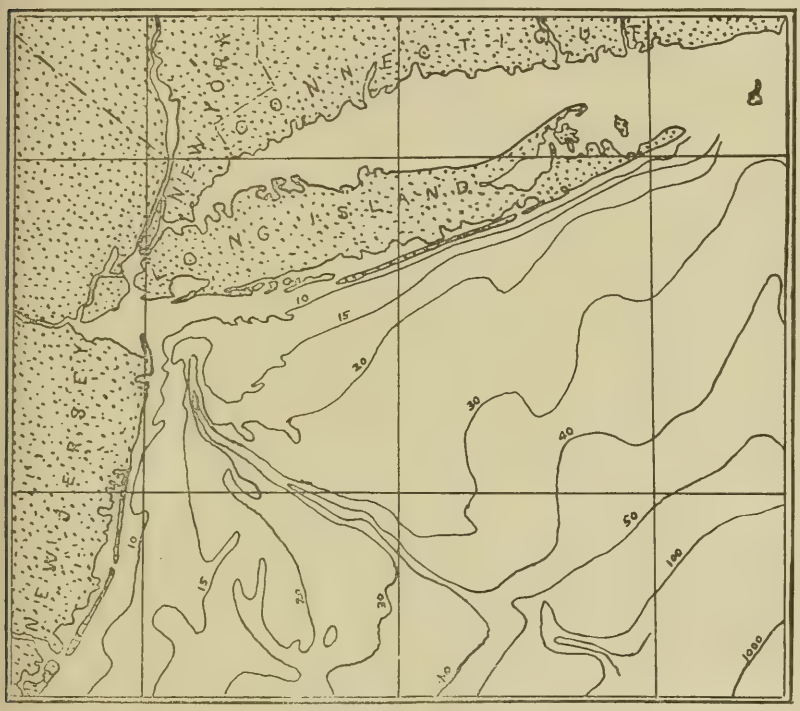


FIG. 28 The submerged Hudson River channel, whose position is clearly shown by the contour lines. Figures indicate depth of water in fathoms. Data from Coast and Geodetic Survey.

into the continental shelf. Even in the Hudson valley above New York City, the narrow inner rock channel has a depth of hundreds of feet (see plate 38) and is mostly submerged below tide water. Without any question this submerged Hudson channel was cut when the region was dry land, and thus we have positive proof that late in the Tertiary, and possibly extending into the early Quaternary, the region of southeastern New York was notably higher than it is today. Conservative estimates place the amount

of elevation greater then than now at not less than 2000 feet because the very end of the Hudson channel is submerged to that extent.[1] The coast was then at what is now the edge of the continental shelf or platform about 100 miles east of the present coast line. That this greater altitude was before the Ice age is proved by the fact that the inner Hudson channel now contains much glacial debris filling. That all of New York State was then higher than now is quite certain because, for example, with the lower Hudson region considerably elevated, the upstate region must also have been elevated (though possibly not so much) in order to maintain the gradients of the actively eroding streams.

To summarize briefly the drainage and physiography of the State during the Tertiary, we may say that, with a certain few important exceptions, the major features as we see them today were practically the same toward the close of the Tertiary, and that these relief features were developed by erosion which began with the uplift of the great peneplain at the opening of this period or the close of the one just preceding. A few of the more notable differences between the drainage of the late Tertiary and the present are as follows: Very few, if any, lakes, waterfalls, or gorges existed; Lakes Erie and Ontario were absent and these basins contained important streams which appear to have drained westward into the Mississippi; the St Lawrence river probably had its source in the Thousand Islands region; the Mohawk river had its source on the divide at Little Falls, while the so-called Rome river flowed westward from Little Falls; West Canada creek entered the Rome river; the Sacandaga river entered the Mohawk; the State, especially the southeastern portion, was notably higher (perhaps not less than 2000 feet) than it now is so that the Atlantic coast line was about 100 miles farther out where the Hudson emptied into the ocean; and Long and Staten islands did not then exist as such.

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[1] It has been suggested by Chamberlain and Salisbury (Geology, vol. 1, page 529) that the very end of the Hudson, and other submerged channels, may have been deepened by tidal scouring and, if so, the figure (2000 feet) generally given may be too high. At any rate the Hudson channel at the Highlands is submerged nearly 800 feet which certainly implies an altitude of more than 1000 feet greater than now when the river was actively eroding.

Glaciated surface of Onondaga (Devonic) limestone at Cheektowaga, Erie county. The passage of the great ice sheet over this ledge of rock wore it down to a generally smooth surface, except for the scratches which were produced by the abrasion of small rocks or pebbles at the bottom of the ice.

From N. Y. State Mus. Bul 19, pl. 94

QUATERNARY PERIOD, INCLUDING NEW YORK IN THE GREAT ICE AGE

The fact of the Ice age. The Quaternary is the last great period of earth history, and it still continues for it has led up to the present-day conditions. This period was ushered in by the spreading of vast ice sheets over much of northern North America and Europe, which must take rank as one of the most interesting and remarkable occurrences of geological time. On first thought the existence of such vast ice sheets seems unbelievable, but the Ice age occurred so short a time ago that the records of the event are perfectly clear and conclusive. The fact of this great Ice age was discovered by Louis Agassiz in 1837, and fully announced before the British Scientific Association in 1840. For some years the idea was opposed, especially by advocates of the so-called iceberg theory. Now, however, no important event of earth history is more firmly established and no student of the subject ever questions the fact of the Quaternary Ice age.

Some of the proofs of the former presence of the great ice sheet are as follows: (1) polished and striated rock surfaces (see plate 39) which are precisely like those produced by existing glaciers, and which could not possibly have been produced by any other agency; (2) glacial boulders or "erratics" which are often somewhat rounded and scratched, and which have often been transported many miles from their parent rock ledges; (3) true glacial moraines, especially terminal moraines, like that which extends the full length of Long Island and marks the southernmost limit of the great ice sheet; and (4) the generally widespread distribution over most of the glaciated area of heterogeneous glacial debris, both unstratified and stratified, which is clearly transported material and typically rests upon the bedrock by sharp contact.

Ice extent and centers of accumulation. The best known existing great ice sheets are those of Greenland and Anarctica, especially the former which covers about 500,000 square miles. This glacier is so large and deep that only an occasional high rocky mountain projects above its surface, and the ice is known to be slowly moving outward in all directions from the interior to the margins of Greenland. Along the margins, where melting is more rapid, some land is exposed, but often the ice flows out into the ocean where it breaks off to form large icebergs.

The accompanying map (figure 29) shows the area of nearly 4,000,000 square miles of North America covered by ice at the

time of maximum glaciation, and also the three great centers of accumulation and dispersal of the ice. The directions of flow of the ice from these centers have been determined by the study of the directions of a very large number of glacial striae or scratches.

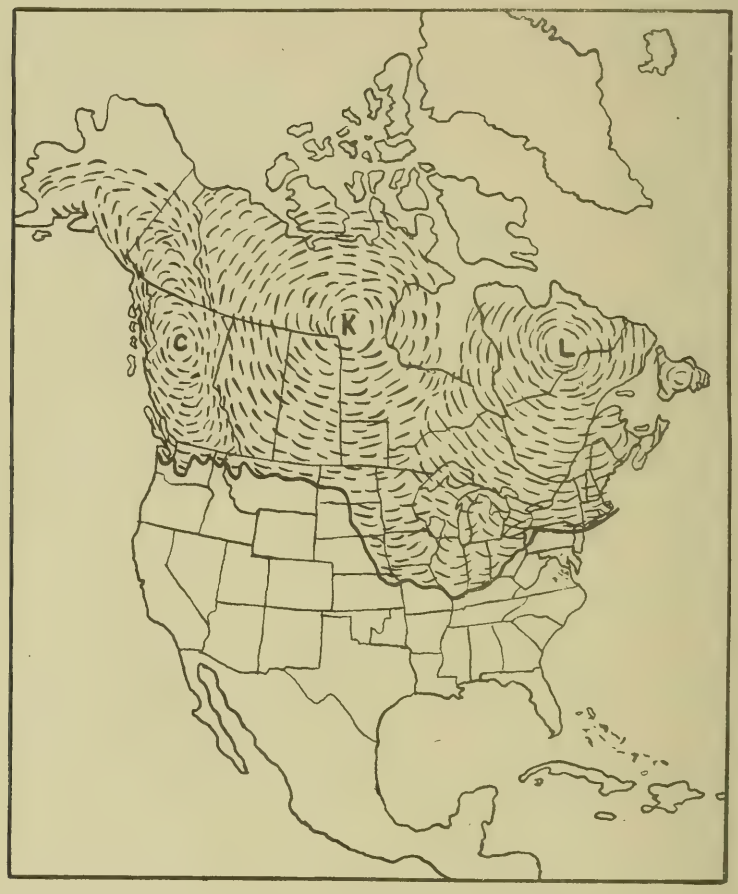


FIG. 29 Map of North America showing the maximum extent of the great ice sheets of the Quaternary period. The three great ice centers are shown by the letters as follows: L = Laborador or Laurentide Glacier; K = Keewatin Glacier; and C = Cordilleran Glacier. All of New York State, except probably the very southern border of Long Island and the southern part of Cattaraugus county, was buried under the ice.

It was the Labradorean or Laurentide ice sheet which spread southward over New York to cover all the State except the southern border of Long Island. It must of course be remembered that the

north Atlantic coast line was then considerably farther out than now because of the greater elevation of the land.

Direction of movement and depth of ice in New York. The fact that glacial ice flows as though it were a viscous substance is well known from studies of present-day glaciers in the Alps, Alaska, or the Greenland ice sheet. A common assumption, either that the land at the center of accumulation must have been thousands of feet higher or that the ice there must have been immensely thick, in order to permit flowage so far out from the center, is not necessary. For instance, if one proceeds to pour viscous tar slowly in one place upon a perfectly smooth (level) surface, the substance will gradually flow out in all directions, and at no time will the tar at the center of accumulation be very much thicker than at other places. The movement of the ice from one of the great centers was much like this, only in the case of the glacier the accumulation of snow and ice was by no means confined to the immediate centers of accumulation.

When the Labradorean ice sheet spread out southward as far as northern New York, the Adirondack mountains stood out as a considerable obstacle in the path of the moving ice, and the tendency was for the current to divide into two portions, one of which passed southwestward up the low, broad St Lawrence valley, and the other due southward through the deep, narrow Champlain valley. As the ice kept crowding from the rear, part of the St Lawrence ice lobe pushed into the Ontario basin, while another portion pushed its way up the broad, low Black river valley and finally into the Mohawk valley. At the same time the Champlain ice lobe found its way into the upper Hudson valley, and sent a branch lobe up the broad, low Mohawk valley. The two Mohawk lobes, the one from the west and the other from the east, met in the Mohawk valley not far from Little Falls. As the ice sheet continued to push southward, all the lowlands of northern New York were filled, a tongue or lobe was sent down the Hudson valley, and finally the whole State, except the southern border of Long Island, was buried under the ice. The general direction of ice movement at this time of greatest ice extent was southward to southwestward with perhaps some undercurrents determined by the larger topographic features. Thus we learn that the major relief features of the State very largely determined the direction of ice currents, except at the time of maximum glaciation when only the undercurrents were controlled.

These ideas are abundantly borne out by the character and distribution of the glacial striae and boulders over the State. Central

New York is literally strewn with thousands of glacial boulders or erratics which were transported from the Adirondacks by the ice, and similar boulders are occasionally found as far south as Binghamton or well down the Hudson valley. Evidences of glaciation also occur high up in the Adirondacks and the Catskills, so that the greatest depth of ice over New York State could not have been less than several thousand feet. In fact, we have every reason to believe that the Adirondacks, if not the Catskills, were completely buried. The reader may wonder how an ice sheet a mile thick in northern New York could have thinned out to disappearance at or near the southern border of the State, but observations on existing glaciers show that it is quite the habit of extensive ice bodies to thin out very rapidly near the margins, thus producing steep slopes along the ice fronts.

Successive ice invasions. The front of the great ice sheet, like that of ordinary valley glaciers, must have shown many advances and retreats. In the northern Mississippi valley, however, we have positive proof for several (perhaps five or six) important advances and retreats of the ice which gave rise to true interglacial stages. The strongest evidence is the presence of successive layers of glacial debris, a given layer often having been oxidized, eroded, and covered with vegetation before the next (overlying) layer was deposited. In drilling wells through the glacial deposits of Iowa, for example, two distinct deposits or layers of vegetation are often encountered at depths of from 100 to 200 feet. Near Toronto, Canada, plants which actually belong much farther south in a warmer climate have been found between two layers of glacial debris. Thus we know that some, at least, of the ice retreats produced interglacial stages with warmer climate and were sufficient greatly to reduce the size of the continental ice sheet or possibly to cause its entire disappearance.

In New York State no very positive evidence has as yet been found to prove truly multiple glaciation, though some phenomena as, for example, certain buried gorges, are very difficult to account for except on the basis of more than one advance and retreat of the ice. At any rate, there appears to be no good reason whatever to believe that there were more than two advances and retreats of the ice over the State, and for our purpose in considering only the general effects of glaciation we may practically disregard the problem of multiple glaciation because the final effects would have been essentially the same as a result of a single great glacial advance and retreat.

Ice erosion. Ice, like flowing water, has very little erosive effect upon rocks unless it is properly supplied with tools. When flowing ice is shod with hard rock fragments the power to erode is often pronounced because the work of abrasion is mostly accomplished by the rock fragments rather than by the soft ice itself. For instance, when the great ice lobe moved up the St Lawrence valley it was shod with many pieces of hard Precambric rocks, and the effects of erosion are remarkably well shown in the Thousand Islands region. Thus, about two miles due south of Clayton the writer has seen a succession of great grooves, covering an area of several acres, and cut into the hard, fresh Potsdam sandstone on top of a low hill. A little search will reveal polished and scratched or grooved rock surfaces in almost any part of the State. Granite ledges in the Adirondacks are often glaciated, and the freshness and hardness of the surface rock proves that the ice eroded all the deep preglacial soil as well as the zone of rotten rock, and an unknown amount of live or fresh rock.

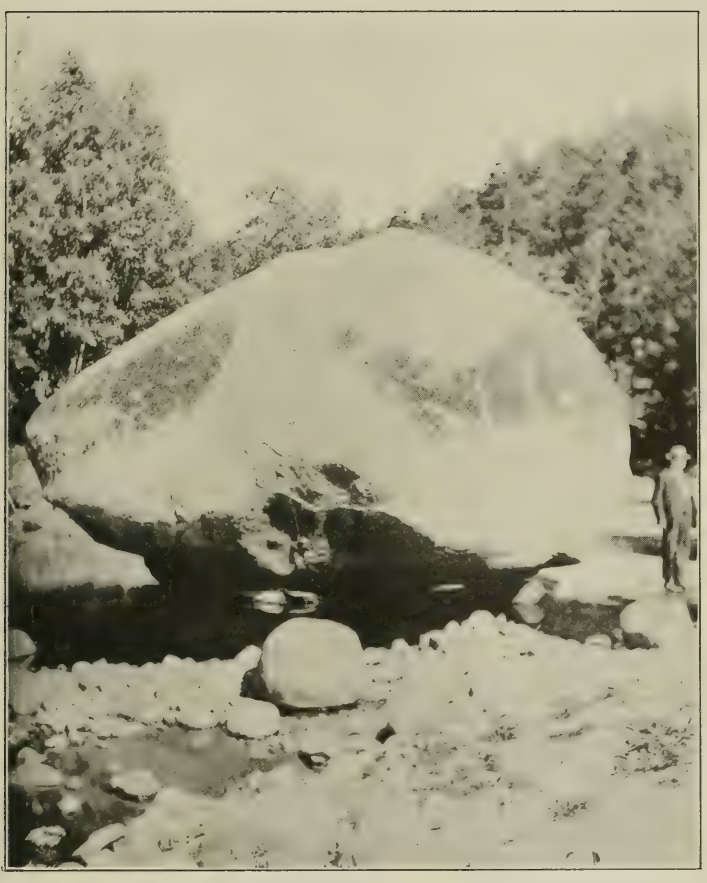
In former years a very great erosive power was ascribed to flowing ice, but today some glacialists consider ice erosion to be almost negligible, while many others maintain that, under favorable conditions, flowing ice has a very considerable erosive effect. During the very long preglacial time, rock decomposition must have progressed so far that rotten rock, including soils, had accumulated to considerable depths, as today in the southern states. Such soils are called "residual" because they are derived by the decomposition of the very rocks on which they rest. But now one rarely ever sees rotten rock or soil in its original place in New York because such materials were nearly all scoured off by the passage of the great ice sheet, mixed with other soils and ground up rock fragments and deposited elsewhere. Such are called transported soils. Along the southern side of the State, where the erosive power of the ice was least, rotten rock is not so uncommonly seen.

Ice, shod with hard rock fragments and flowing through a deep, comparatively narrow valley of soft rock, is especially powerful as an erosive agent because the abrasive tools are supplied; the work to be done is easy; and the increased depth of the ice where crowded into a deep, narrow valley causes greater pressure on the bottom and sides of the valley. Many of the valleys of northern New York were thus very favorably situated for ice erosion, as for example, the Champlain, St Lawrence, Black river, and Finger lakes valleys, as well as many of the nearly north-south valleys of the Adirondacks. The writer has made a special study of ice

erosion in the Black river valley, and figure 35 is a structure section across the valley showing the rock terraces and the relations of the various rock formations. The high, steep, terrace fronts are certainly young topographic features which could not have been present at the close of the long preglacial erosion period, nor could they have been formed since the Ice age because glacial deposits, even near the valley bottom, have not yet been removed. There is still the possibility that glacial waters may have done the work, but there is no evidence for such vigorous water action especially on the higher part of the Trenton limestone terrace where records would surely be left. On the contrary, there are glaciated rock surfaces and also glacial deposits (kames) on the great limestone terrace and near the base of the steep front of the shale terrace, so that the work could not have been done by glacial waters before the ice retreat. Evidently, we have here a fine example of ice erosion, and before the Ice age the limestones and shales extended somewhat farther eastward than they now do. The conditions for ice erosion were here unusually favorable because the ice, in its great sweep around the Adirondacks, was shod with many fragments of very hard rocks and entered the deep Black river valley striking with greatest force against the soft sedimentary rocks of the west side of the valley. As the figure clearly shows, the very soft shales were worn back more than the harder limestones, while the very hard Precambric rocks were very little affected. This is perhaps the best example of ice erosion in northern New York, and even here we must admit that only soft rocks were much eroded and that the great preglacial Black river valley was comparatively little modified. If soft shales had made up the valley bottom, ice erosion would have caused considerable deepening as was, no doubt, the case in the valleys of the Finger lakes region.

Most of the Adirondack mountain peaks, especially the more isolated ones, were thoroughly scraped off and rounded down to the very live or fresh rock (see upper view, plate 17), while the favorably situated valleys were vigorously glaciated by the removal of all the rotten and at least some of the fresh rock, especially when this latter was the comparatively soft Grenville limestone. Such phenomena are particularly well exhibited in Warren county (see figure 13) where the landscape is characterized by many great, glaciated rock domes which rise above the valleys of weak Grenville. In a few cases where the ice moved directly across deep valleys, like that between Lake George village and Warrensburg, the rotten rock to great depth may still be seen in its original place.

Plate 40



A glacial boulder or "erratic" of Precambric syenite in the bed of Black river, 2 miles northeast of Boonville, Oneida county. The boulder is 27 feet across and 17 feet high and rests upon Black River limestone. It has been transported some miles at least.

Photo by W. J. Miller

Plate 41

Drumlins in Wayne county, 3 miles north of Walworth. Looking east of south.

From N. Y. State Mus. Bul. 111, pl. 25

In conclusion we may say that while many comparatively small, local features were produced by ice erosion, the major topographic features of the State were practically unaffected by ice erosion due to the passage of the great ice sheet.

Ice deposits. The vast amount of debris transported by the great ice sheet was carried either on its surface, or frozen within it, or pushed along under it. It was very heterogeneous material ranging from the finest clay through sand and gravel, to boulders of many tons weight. The deposition of these materials, as we now see them, took place during both the advance and retreat of the ice, but chiefly during its retreat. Most of the deposits made during the ice advance were obliterated by ice erosion, while those formed during the ice retreat have been left intact except for the small amount of postglacial erosion. The general term applied to all deposits of glacial origin is "drift," this term having been given at the time when they were regarded as flood deposits. Drift deposits cover practically all of New York State except where bare rock is actually exposed, and its thickness is very variable, ranging from nothing to several hundred feet.

The ice sheet could advance only when the rate of motion was greater than the rate of melting of the ice front and vice versa in the case of retreat. Thus it is true, though seemingly paradoxical, to assert that the ice was constantly flowing southward even while the ice front was retreating northward. Whenever, during the great general retreat, the ice front remained stationary because the forward motion of the ice was just counterbalanced by the melting, all the ice reaching the margin of the glacier dropped its load to build up a *terminal moraine*. Such a moraine is a more or less distinct range of low hills and depressions consisting of very heterogeneous and generally unstratified debris, though at times waters emerging from the ice caused stratification. The depressions are usually called *kettle holes*. The so-called great terminal moraine marks the southernmost limit of the ice sheet, and is wonderfully well shown by the ridge of low irregular hills extending the whole length of Long Island (see plate 12). It is also clearly traceable across northern New Jersey and Pennsylvania and passes through southern Cattaraugus county in New York. Terminal moraines farther northward are generally not so long nor sharply defined, the one of perhaps most prominence having been traced from Herkimer through Oriskany Falls, Cortland, Watkins, Bath, Portageville, Dayton, and Jamestown. Moraines, either terminal or lateral, are often locally very prominently developed.

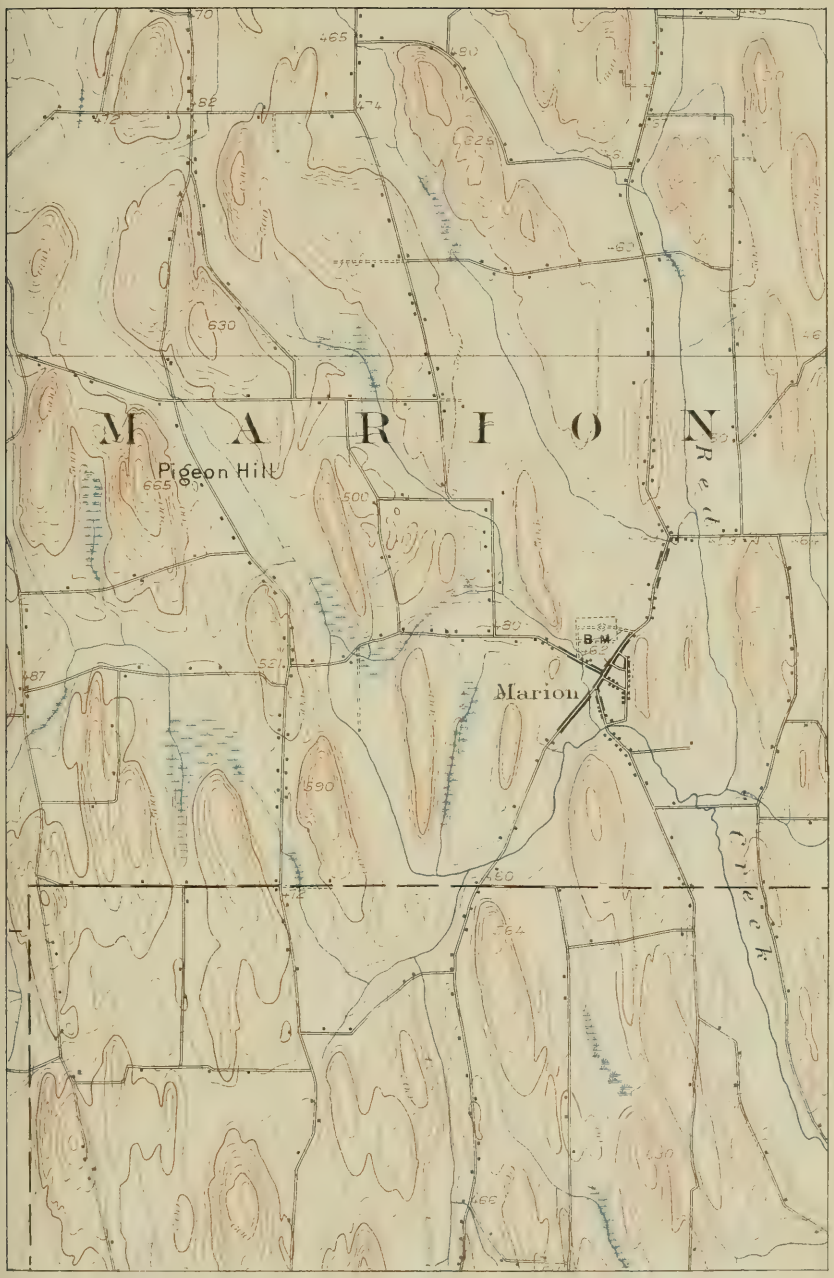
When the ice front paused for a considerable time upon a rather flat surface, the debris-laden streams emerging from the ice formed what is called an *overwash plain* by depositing layers of sediment over the flat surface. The finest illustration of such an overwash plain in the State is all of that part of Long island lying just south of the great terminal moraine, and known as the Jamaica plain toward the east (see plate 12).

When the ice front extended across a more rugged country, with valleys sloping away from the ice, the large glacial streams, heavy laden with debris, caused more or less deposition of materials on the valley bottoms often for many miles beyond the ice front. Such deposits, known as *valley trains*, are especially well developed along most of the large south-flowing tributaries of the upper Susquehanna river in the Southwestern plateau province.

Glacial boulders, or erratics, have already been referred to; they are simply blocks of rock or boulders from the top of the ice or within it which have been left strewn over the country as a result of the melting of the ice. They vary in size from small pebbles to those of many tons weight (see plate 40), and are naturally most commonly derived from the harder and more resistant rock formations. Thus erratics from the Adirondacks are very numerous in east-central New York, some having even been transported to the southern border of the State. Erratics are often found high up on the mountains, and sometimes they have been left stranded in remarkably balanced positions.

A very extensive glacial deposit, called the *ground moraine,* is simply the heterogeneous, typically unstratified, debris from the bottom of the ice which was deposited, sometimes during the ice advance, but most often during its melting and retreat. When it is mostly very fine material with pebbles or boulders scattered through its mass, it is known as *till* or *boulder clay*. The pebbles or boulders of the till are commonly faceted and striated as a result of having been rubbed against underlying rock formations.

Another type of glacial deposit of unusual interest is the *drumlin* which is, in reality, only a special form of ground moraine material or till. The typical drumlins of New York State are low, rounded mounds of till with elliptical bases and steeper slopes on the north sides and with long axes parallel to the direction of ice movement (see plate 42). In height they rarely exceed 200 feet, being most often less than 100 feet. The origin of the drumlins has not yet been satisfactorily determined, though it is known that they formed near the margin of the ice either by the erosion of an earlier drift



A topographic map illustrating that part of the Ontario plain which is studded with low, elliptical-shaped hills (drumlins) of glacial origin. Practically every hill seen from the train window between Syracuse and Rochester is a drumlin. From the Palmyra (U. S. G. S.) quadrangle. Scale, about 1 mile to the inch.

Typical glacial topography as seen near West Junius, Ontario county. The low, irregular hills all consist of stratified glacial debris and are known as "kames."

From Annual Rep't N. Y. State Geol., 1894, pl. 8, facing p. 80

layer, or by accumulation beneath the ice under peculiarly favorable conditions, as perhaps along longitudinal crevasses or fissures. One of the finest and most extensive exhibitions of drumlins in the world is the region of western New York from Oswego and Syracuse to west of Rochester. Thousands of drumlins there rise above the general level of the Ontario plain, the New York Central Railroad, from Syracuse to Rochester, passing through the very midst of them.

Another type of glacial deposit in the low hill or hillock form is the *kame* which, in contrast with the drumlin, always consists of stratified drift. Kames are seldom as much as 200 feet high, and typically they have rounded bases though frequently they are very irregular in shape. At times they exist as isolated masses or hills or in small groups, while often they are associated with the unstratified deposits of the moraines. When grouped, deep depressions occur between the hills to form what is called the knob and kettle structure. Kames were formed at or near the margin of the retreating ice, and so are found in all parts of the State. They most generally occur in valley bottoms, but sometimes on hillsides or even hilltops. They are especially common along the line of the great terminal moraine (for example, on Long island), and also along the line of the important terminal moraine already described from central to western New York. For example, in the vicinity of Oriskany Falls kames are so numerous as to form a striking feature of the landscape in the Oriskany valley. They were formed as deposits by debris-laden streams emerging from the margin of the ice, the water sometimes having risen like great fountains because of pressure. Such deposits are now actually in process of formation along the edge of the great Malaspina glacier of Alaska.

During the retreat of the ice, glacial lakes were numerous, especially after the ice front had passed north of the Susquehanna-Allegany divide because the north-sloping valleys were dammed by the ice thus ponding the waters in the valleys. Some materials were directly deposited from the glacier in those lakes, but more was brought in by debris-laden streams flowing from the land already freed from the ice. Such glacial lakes and their deposits are common and of unusual interest, but they will be described under a subsequent heading.

In conclusion we may say that the deposition of glacial materials, like glacial erosion, has not changed the major topographic features of the State. The general tendency of ice deposits has been to fill or partially fill depressions and thus to diminish the ruggedness of the topography.

Great Lakes history. The Great Lakes certainly did not exist before the Ice age, but instead the depressions in that region were occupied by stream channels. During the very long erosion period (already discussed) from the Paleozoic to the Cenozoic, no lakes, except possibly a few very small ones due to landslides, beaver dams, etc., could have existed. Compared with such an immense length of time lakes are, at most, only ephemeral features of the earth's surface because they are soon destroyed either by being filled with sediments, or by having their outlets cut down, or both. Since the Great Lakes are of postglacial origin it is, then, proper to ask how they came into existence. During preglacial time, as we have learned, broad valleys were cut out along belts of weak rock in the Great Lakes region, and these old valleys, to a considerable extent at least, account for the present depressions, but not for the closed lake basins. This idea of preglacial stream valleys is not at all opposed by the fact that some of the lake bottoms are now well below sea level because there has been a notable subsidence of the region since preglacial time. The surface of Lake Erie is 573 feet and its deepest point 369 feet above sea level, while the surface of Lake Ontario is 247 feet above and its deepest point is 491 feet below sea level. The greatest depth (738 feet) of Lake Ontario is well toward the east end and not far from the south shore, and if we consider this deep place as due to preglacial erosion, we ought to find an outlet channel. But no such outlet channel exists because the whole eastern end, at least, of the lake is certainly rock-rimmed. As Tarr has said: "There could hardly be a valley over 700 feet deep and broad enough to form the continuation of the preglacial Ontario valley, which is so completely obscured by drift that not the least trace of it has been found on the surface."[1] To assume that this deep part of the basin was produced by warping of the land is not borne out by examining the exposed strata on all sides. It therefore seems quite certain that the preglacial Ontario depression was here considerably deepened by ice erosion. The conditions were very favorable for such erosion because the rocks were chiefly soft Ordovicic shales; because the ice flowed through a deep preglacial valley; and because there was unusual crowding of ice into this valley due to the pronounced deflection of a great ice current around the Adirondacks on the west side. Strong arguments might be adduced to show that by ice erosion, portions, at least, of all the

[1] Tarr's Physical Geography of New York State, p. 235.

lake basins were appreciably deepened. Even so, however, we have not yet accounted for the present closed basins. In the writer's opinion the two most important phenomena which have contributed to the formation of the closed basins of the Great Lakes are the great drift accumulations along the south side and the tilting of the land downward on the north side of this region. The deep drift deposits must certainly have been very effective in damming up the south or southwesterly-flowing preglacial streams of the region. For example, the deep channel of the so-called Dundas

FIG. 30 The first stage in the formation of the Great Lakes, when most of the region was still buried under the ice.

After Taylor & Leverett

river (see figure 27) has been drift-filled as proved by many well borings, and a distinct moraine extends around the southern half of Lake Michigan. The great dumping ground of ice-transported materials from the north was in general along the southern side of the Great Lakes and southward. Late in the Ice age the land on the northern side of the Great Lakes region was lower than it is today as proved by the tilted character of certain well-known beaches of extinct glacial lakes (see below). Such a differential tilting or warping of the land must have helped to form the closed basins by tending to stop the southward or southwestward drainage

from the region. To summarize, we may say that the present Great Lakes basins are due to a combination of factors, the more important of which were: the formation of preglacial valleys by stream erosion; a more or less deepening of these valleys by ice erosion; the great accumulation of glacial debris along the southern side of the Great Lakes region; and the tilting of the land downward toward the north.

We are now ready to trace out the principal stages in the history of the Great Lakes during the final retreat of the ice sheet. When the ice front had receded far enough northward to uncover the western end of Lake Superior, the southern end of Lake Michigan, and an area west of the present end of Lake Erie, small lakes were formed against the ice walls (see figure 30). One of these has been called Lake Duluth which drained southward into the Mississippi; the second Lake Chicago which drained past Chicago through the Illinois river and into the Mississippi; and the third Lake Maumee which drained southwestward past Fort Wayne through the Wabash river and into the Ohio and Mississippi.

At a still later stage the conditions shown on the map (figure 31) existed. Lake Chicago was then much larger, and Lake Maumee

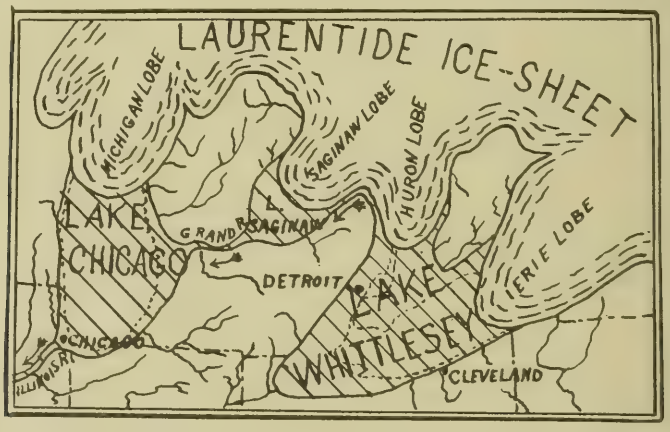


FIG. 31 A later stage of Great Lakes history, showing how the eastern and western ice margin lakes combined with outlet past Chicago.

After Taylor

had expanded into the extensive Lake Whittlesey which covered nearly all of Lake Erie as well as the immediately surrounding country. Lake Whittlesey was at a lower level than the former Maumee and the outlet past Fort Wayne ceased, but the drainage

from Whittlesey was westward by a large river flowing through small Lake Saginaw and into Lake Chicago, which latter still emptied through the Illinois river.

At a still later stage (figure 32) Lake Saginaw merged with the waters of the Erie basin to form the large Lake Warren which extended along the ice front eastward nearly to central New York. As the map clearly shows, the Finger lakes basins of New York were then occupied by Warren waters, while Niagara Falls were not then in existence because that region was also covered by Lake Warren. Lake Warren continued to discharge westward into Lake Chicago and the Mississippi river until a very late stage, when the waters had worked their way along the border of the Ontario ice

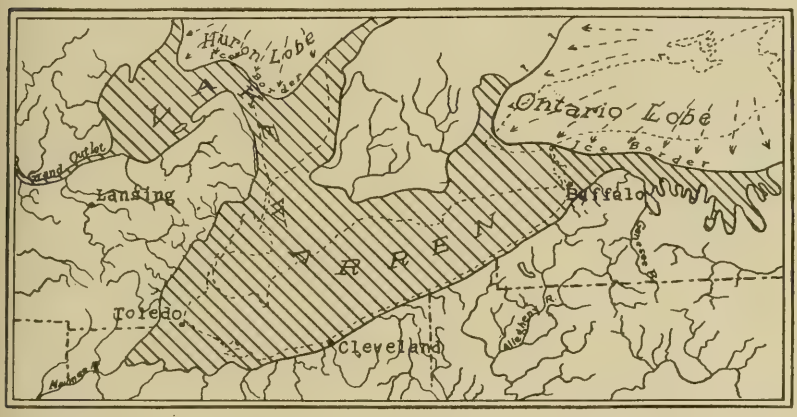


FIG. 32 Glacial Lake Warren. At this stage the discharge of the lake was still westward to Lake Chicago and the Mississippi river, while the eastern end of the lake covered most of the Finger Lakes region of New York.

Modified from Taylor & Leverett, U. S. G. S.

lobe into the Mohawk valley which was then occupied by a large glacial lake (held up by the Ontario ice lobe on the west and the Champlain-Hudson lobe on the east) and thence into the Hudson valley. Thus, for the first time, the Great Lakes drainage passed eastward into the Atlantic ocean. This great volume of water draining eastward was often in the form of distinct streams with the ice front for north wall and the high land of the Helderberg escarpment for wall on the south. Many of these glacial stream channels, which are still plainly visible, have been studied and mapped by Professor Fairchild.

By successive stages, due to a complete removal of ice from central New York and a draining of the glacial lake in the Mohawk valley, the waters dropped to below Warren level until Lake Iroquois was formed (see figure 33). The old beach line of this lake is still plainly visible in New York and with some slight interruptions has been traced from near the mouth of Niagara river to just north of Rochester, past Syracuse, along the south, east, and north sides of Oneida lake, and thence along the western base of the Tug Hill plateau to near Watertown. The well-known ridge road between Niagara river and Rochester is built on the old

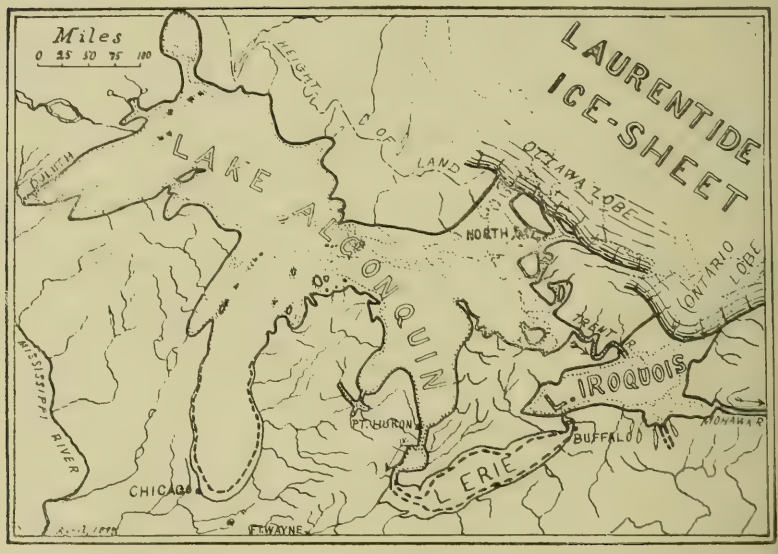


Fig. 33 The Algonquin-Iroquois stage of Great Lakes history when the ice had retreated far enough to open the outlet through the Mohawk valley.

After Taylor

Iroquois beach deposit. Lake Iroquois covered somewhat more than the present area of Lake Ontario, and the distinctly lower water level here than in the Erie basin allowed the modern Niagara river to begin its history by flowing northward over the limestone plain near Buffalo. Meantime the waters of the upper lake basins had merged to form Lake Algonquin which at first probably discharged past Detroit through the Erie basin and into Lake Iroquois by way of Niagara river. Later, however, when the ice had withdrawn a little farther northward, a lower outlet was opened through the Trent river by which Lake Algonquin drained into Lake

Iroquois. We know that the old Trent river channel is now higher than the Detroit outlet, but some of the proofs for the existence of the Trent outlet are as follows: the presence there of a large, distinct river channel; the convergence of the beaches toward that channel; and the fact that the land was then considerably lower on the north or northeast side of Lakes Ontario and Erie than on the south side. For example, in following the old Iroquois beach we find that it now gradually rises to higher levels until, even at Watertown, it is several hundred feet higher than near the mouth of the Niagara river. This tilting of the beach has been due to raising of the land since the lake existed, and it is evident therefore that during the Algonquin-Iroquois stage the Trent river channel was lower than that past Detroit. During this Lake Iroquois stage the waters of all the Great Lakes region discharged through the Mohawk-Hudson valleys, and the volume of water which flowed past Rome, Utica, and across the preglacial divide at Little Falls must have been as great, if not greater, than that which now goes over Niagara Falls. Much of the gorge cutting at Little Falls was accomplished by this great volume of water. The St Lawrence valley was still buried under the ice.

Still later the ice withdrew enough to allow the Algonquin-Iroquois waters to discharge along the northern base of the Adirondacks and into what appears to have been ice-ponded waters in the Champlain basin, and thence southward into the Hudson valley. The Mohawk river outlet was thus abandoned.

Finally the ice retreated far enough to free the St Lawrence valley when the waters of the Great Lakes region dropped to a still lower level, bringing about the Nipissing Great Lakes stage (see figure 34). The Nipissing lakes found a low outlet through the Ottawa river (then free from ice) and into the Champlain arm of the sea. Postglacial warping of the land brought the Great Lakes region into the present condition, but this, and the Champlain subsidence, being really postglacial features will be described toward the end of the chapter.

Other existing lakes and their origin. Counting all, from the smallest to the largest, there are within the borders of New York State thousands of lakes, which constitute one of the most striking differences between the geography of the present and that of preglacial time. These lakes are widely scattered over the State though there are three general regions worthy of particular mention as follows: the Finger lakes region of western New York; the Adirondack mountains; and the southeastern portion of the State.

The linear type of lake is by far the most common, this being preeminently true of the Finger lakes and to a large extent of the Adirondacks. It is well known that most of the larger lakes, especially those of the linear type, occupy portions of preglacial stream channels. All the existing lakes are due, either directly or indirectly, to glacial action, and among the ways by which such bodies of water were formed are these: by building dams of glacial drift across old river channels; by ice erosion; and by the filling of the numerous depressions which were formed by irregular deposition of the drift (kettle holes, etc.). Hundreds of small lakes, often

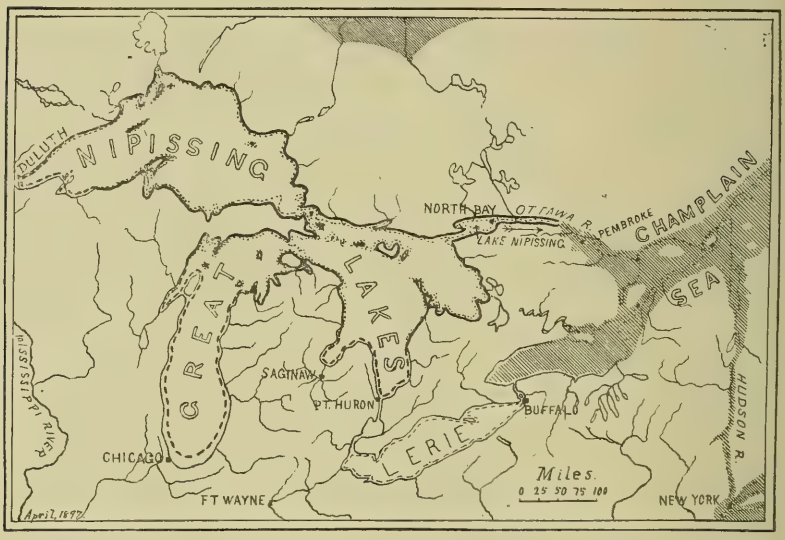


FIG. 34 The time of the Nipissing Great Lakes and Champlain submergence. The shaded area on the east was covered by sea water.

After Taylor

not more than mere ponds in size, belong to the last named type, while most of the large lakes are due chiefly to the existence of drift dams.

Much has been written concerning the origin of the Finger lakes, and only the briefest summary will here be given. All are agreed that the lakes of this remarkable group occupy preglacial valleys, most of which, at least, contained north-flowing streams. These lakes have dams of glacial drift across their lower (north) ends, and the dams have largely contributed to the formation of the lakes, being in some cases perhaps the sole cause of the lakes. In the

cases of the two largest lakes, Seneca and Cayuga, there is, however, strong evidence that the preglacial channels were notably deepened by ice erosion.[1] As Professor Tarr says: "They offered broad channel ways, along which the ice streams moved much more easily than upon the neighboring irregular hilltops. Not only was the movement more rapid, but the depth of ice was greater. The position of the rocks, dipping southward, and the nature of the friable shales conspired toward rapid erosion; and so these north and south preglacial valleys were markedly deepened. Evidence of this comes from the side streams. The rock bottoms of the preglacial valleys of these tributary streams are not now below the level of the lake water in the southern part of the valley (Cayuga). If all the drift could be removed and the streams be allowed to flow along the line of the course of the preglacial valleys and enter the valley of Lake Cayuga as it now stands, excepting that it be robbed of water, they would tumble between 300 and 400 feet in a distance of about a mile, commencing their descent near the present lake margin, a most unnatural condition for mature tributaries near their mouth."[2] Thus it appears quite certain that the preglacial Cayuga and Seneca valleys, at least, were notably deepened by ice erosion below the level of the mouths of the preglacial tributary streams.

Most of the numerous Adirondack lakes have certainly been formed by irregular damming of preglacial valleys by glacial drift. It is quite the rule to find the outlets of these lakes flowing through such loose materials. By ice erosion many of the favorably situated valleys were no doubt somewhat modified, but up to the present time we have no good example of a lake basin produced by that agency. The hard Precambric rocks were not so easily eroded by the ice. Attention is called to the prominent lake belt in the middle of the Adirondack province, and running in a north-northeast by south-southwest direction. This belt comprises many well-known lakes as Placid, Saranac, Tupper, Long, Blue Mountain, Big Moose, and Fulton Chain lakes. Sometimes small lakes or ponds are situated well toward mountain tops because of favorably located drift deposits. A good example of such lake lies at an altitude of 2620 feet, and well toward the top of Crane mountain in Warren county.

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[1] The surfaces of Seneca and Cayuga lakes are respectively 444 and 381 feet above sea level, while their deepest places are respectively 186 and 119 feet below sea level.

[2] Tarr's Physical Geography of New York State, p. 181–82.

Many of the existing Adirondack lakes were formerly of larger extent as proved by delta deposits above the present lake levels. Two lakes of this class recently coming under the writer's observation are Schroon lake in Warren-Essex counties, and Piseco lake in Hamilton county. The water of Schroon lake was once fully 70 feet higher when it extended some eight or ten miles farther up the Schroon river, with a branch reaching over the area of the present Paradox lake, and also for some six or eight miles farther southward to cover all the lowland around Chestertown, and with a prominent branch extending over the area of the present Brant lake. Piseco lake was at one time clearly twenty feet higher, and then extended several miles farther northward.

The valley of Lake Champlain was favorably situated for ice erosion, and it bears evidence of having been vigorously glaciated though it has not been proved that the existing closed basin is chiefly due to ice erosion. At the close of the Ice age, tide water entered the valley. The present lake basin is due principally to a combination of late elevation of the land, with greater uplift on the north; heavy glacial accumulations toward the north; and possibly some deepening as a result of ice erosion.

Lake George is justly famous because, from the standpoint of length and depth in proportion to width, no other lake in the State occupies such a remarkable depression. This depression has been determined by ordinary erosion along lines of prominent faults. There was a preglacial divide where the "Narrows" are now located, and this divide appears to have been considerably lowered by ice erosion when part of the Champlain ice lobe plowed its way through the deep, narrow valley. The waters are now held in by glacial deposits at each end.

In southeastern New York, from the Connecticut state line westward to the southern Catskills in Sullivan county, there are many lakes, though all are comparatively small. With few exceptions these lakes appear to be of the usual drift dam type. Greenwood lake, at an altitude of 621 feet and passing from Orange county across the state line into New Jersey, is the largest in this part of the State. Three small lakes near the summit of Shawangunk mountain, and close to its eastern edge, deserving special mention are: Mohonk, Minnewaska, and Awosting. Mohonk lake, which is so widely known both because of its remarkable situation and as a place where so many peace conferences have been held, may be taken as the type of the three. The altitude of this lake is more than 1200 feet or about 1000 feet above the base of the mountain

ridge on which it is located. It is almost completely surrounded by walls of hard Shawangunk conglomerate, while the lake basin itself is in the soft underlying Ordovicic shales. This lake does not appear to owe its origin to a dam of glacial drift, but rather to ice erosion in the soft shales at a place where they had already been exposed to view before the oncoming of the ice. Such patches of shale occur at several places on the mountain.

Near the very western end of the State lies another lake remarkably situated. This is Lake Chautauqua, famous as the great center of Chautauqua assemblies. The altitude of the lake is 1338 feet, and its northern end is near the edge of the steep front of the Southwestern plateau province where it overlooks the low Erie plain. The drainage is southward into the Allegheny river, but the narrow place near the middle of the lake strongly suggests a preglacial divide there. As Tarr says: "If this view be true, Chautauqua lake is made up of parts of two valleys, one north-sloping, the other south-sloping, and each dammed by heavy morainic accumulations."[1]

Extinct glacial lakes. Hundreds of extinct glacial lakes are known to be scattered over the State. Some of these existed only during the time of the ice retreat, while others persisted for a greater or lesser length of time after the Ice age. Lakes Warren, Iroquois etc., already described, were fine examples of the first type. North-sloping valleys were particularly favorable for the development of glacial lakes during the retreat of the ice because the ice front always acted as a dam across such valleys, thus allowing the waters to become ponded. When the ice front stood across the northern ends of the Finger Lakes valleys, the waters in those valleys were ponded at much higher levels than they now are, and the ancient water levels are more or less clearly marked by the old beach lines.

Perhaps the finest example of a large, wholly extinct glacial lake is Black lake, which occupied a good portion of the Black river valley on the western side of the Adirondacks. This lake, small at first, was formed by ponding the waters in the upper Black river valley around Forestport, Oneida county, in front of the waning (northward retreating) ice lobe in the Black river valley. Its first discharge was probably southward past Remsen. Further retreat of the ice lobe permitted an enlargement of the lake to the region around Boonville, and the discharge was then southward along the channel of the present Lansing kill. The deep, narrow gorge a

[1] Tarr's Physical Geography of New York State, p. 205.

few miles south of Boonville, along this stream, was mostly cut by the fairly large stream which drained the glacial lake at this stage. The southward discharge through this channel appears to have been into the Lansing Kill lake where a delta deposit was formed a few miles north of Rome and now the site of the Delta reservoir. Lansing Kill lake in turn drained through the Mohawk Valley. Still further retreat of the ice lobe allowed Black lake to expand greatly until it reached from the region around Forestport to north of Lowville, when it had a width of from five to ten miles. When the ice withdrew enough to permit a discharge of water around the north base of Tug hill, and into Lake Iroquois, the level of the lake rapidly fell until the ice barrier was completely removed. The former presence of this great glacial lake is conclusively shown by the extensive development of unquestioned delta deposits. Where the streams from the Adirondacks, especially the larger ones such as Black, Moose, and Independent rivers, emptied into the lake, delta deposits were rapidly built up to near the lake surface because those streams were heavily charged with debris from the newly drift-strewn mountains. These delta deposits became more or less merged, and they show a remarkable concordance of altitudes over the sand flat or sand plain country on the east side of Black river. This great delta deposit is several miles wide; very flat-topped except where trenched by postglacial streams; presents a steep front toward the river; and shows a depth of from 200 to 250 feet along the western edge. Figure 35 clearly shows the relation of the delta deposit to the old rocks of the valley.

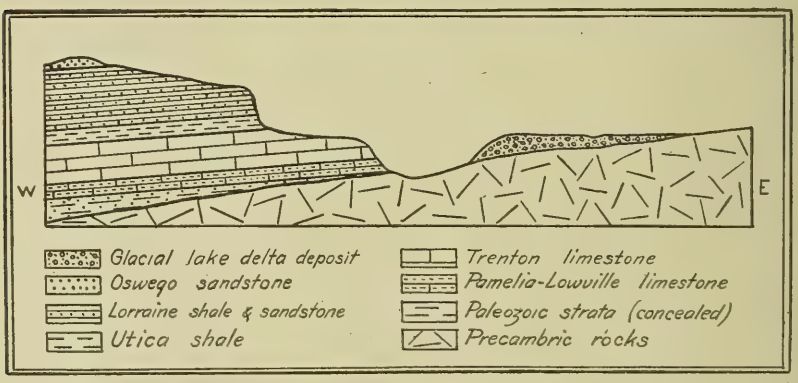


FIG. 35 East-west section across the Black river valley, 2½ miles north of Lyons Falls, showing the terraced character of the Paleozoic strata and their relations to the Precambric Adirondack rocks. On the east side, the position of the glacial lake delta deposit is shown. Length of section 12½ miles. Vertical scale greatly exaggerated.

After W. J. Miller, N. Y. State Mus. Bul. 135

In many cases where the edge of an ice lobe extended across the mouth of an east, or west, or even south-sloping valley, glacial lakes were formed. A fine example of a glacial lake (now extinct) formed in a south-sloping valley has been called glacial Lake Sacandaga which covered many square miles of the bottom of the broad, deep valley in which Johnstown, Gloversville, and Northville are located. Through this valley, which has a width of several miles and a maximum depth of over a thousand feet, the preglacial Sacandaga flowed southward into the Mohawk. During the general ice retreat, but when the Mohawk glacial lobe was still present, morainic deposits along the margin of the ice lobe formed an effective barrier across the mouth of the valley thus ponding the waters over the valley bottom and causing the Sacandaga to find an outlet northeastward over the low divide at Conklingville. The altitude of the lake corresponded approximately with the present 780 foot contour line, though it is quite certain that the land was then somewhat lower. This lake persisted for a good while after the disappearance of the ice because of the effective drift dam, and even today, in the spring of the year, a number of square miles of swamp in the lowest part of the valley are flooded. The lake was drained by cutting down the divide at Conklingville. It is interesting to note in passing that the construction of the proposed Sacandaga reservoir, by means of a dam at Conklingville, would almost exactly restore this former glacial lake.

Many other glacial lakes are known to have been formed by ponding of water alongside the waning Mohawk ice lobe. During the melting of the ice tongue from the Hudson and Champlain valleys, many small glacial lakes are also known to have been formed in the tributary valleys because of ice dams across them.

New York State fairly abounds in such extinct glacial lakes, and though comparatively few have yet been described, they are usually easily recognizable by means of the typical, flat-topped, delta deposits of crudely stratified sands, gravels and clays.

Drainage changes, gorges, and waterfalls. Along with its lakes, New York State is also famous for its numerous gorges and waterfalls, which are also largely due to the great Ice age. As a result of the very long preglacial erosion period, it is perfectly clear that typical, steep-sided, narrow gorges and true waterfalls must have been very uncommon, if present at all. Like lakes, such features are ephemeral because, under our conditions of climate, gorges soon (geologically) widen at the top and waterfalls disappear by retreat or by wearing away the hard rock over which they fall.

Drainage changes, aside from those already described in connection with the history of lakes, are also numerous in New York. It must be remembered that, with few exceptions (for example, the basins of Lakes Ontario and Erie, Niagara river, and possibly the St Lawrence river), the major drainage lines of the State were little changed during the Ice age because the principal valleys were mostly the same before and after glaciation. It is the present purpose briefly to describe only some of the most important and best known cases of stream changes due to the Ice age.[1]

From the standpoint of both geography and human history, the gorge at Little Falls is the most important in New York State (see figure 7 and plate 42 and also the description in chapter 2). Before the Ice age there was a divide, instead of the gorge, several hundred feet above the present river level, which consisted of hard Little Falls dolomite. The prominence of this rock barrier was greatly increased by the tilting of the strata due to the development of the Little Falls fault. The Mohawk river flowed eastward, and the now extinct Rome river flowed westward, from this divide (see figure 36). During the Ice age the divide was somewhat lowered

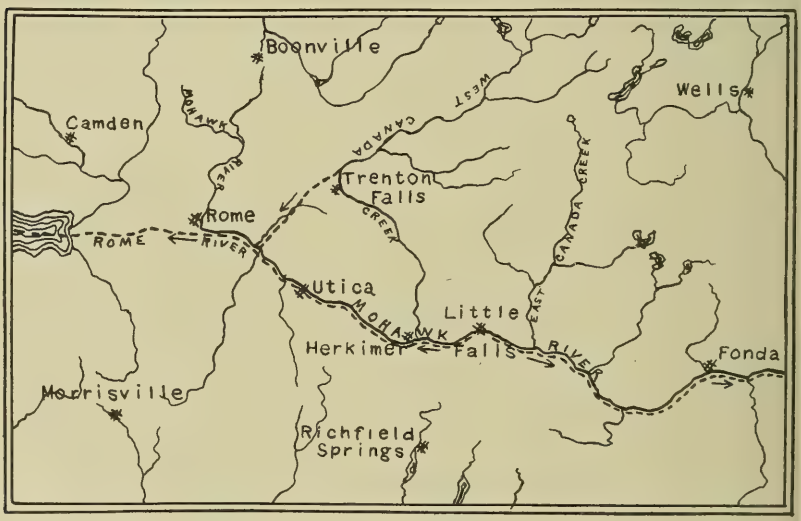


Fig. 36 Sketch map of central New York, showing the relation of preglacial to postglacial drainage. Preglacial streams shown by dotted lines only where essentially different from existing streams.

Based upon work of A. P. Brigham

[1]All the drainage changes now to be described will be much better understood by consulting the large government topographic maps of the regions considered.

General view of the gorge at Little Falls, looking up the Mohawk river from the eastern part of the city. In the bottom of the gorge is Precambric igneous rock (syenite), while the steep hills on either side of the river are of Little Falls (Cambric) dolomite.

From N. Y. State Mus. Bul. 77, pl. 12

by ice erosion, and during the Algonquin-Iroquois stage of the Great Lakes history, we have learned that these lakes discharged through the Mohawk valley and across the Little Falls divide. It was the passage of this great volume of water over the divide which caused the cutting of most of the gorge as we now find it, except for the narrow trench in the hard, underlying Precambric rock which is no doubt due to postglacial erosion. During the Iroquois stage an arm of the lake extended along the valley from Rome to Little Falls. All the streams from north and south which entered this arm of the lake were heavily charged with debris from the newly drift-covered regions and, the current not being strong enough to carry away the debris, the valley from Rome to Little Falls was built up (aggraded) to such an extent that, after the disappearance of Lake Iroquois, the drainage from Rome was able to continue eastward. Thus we have here a very fine example of exact reversal of drainage directly due to glaciation and by this means the upper waters of the Mohawk were added to the preglacial Mohawk.

Closely associated with the above is the postglacial history of West Canada creek and the famous chasm at Trenton Falls. The preglacial West Canada creek flowed from Prospect (upper end of Trenton chasm) past Holland Patent, through the valley of the present Nine Mile creek, and into the Rome river opposite the village of Oriskany. This channel was completely blocked by glacial drift at Prospect so that the creek was forced to find a new course southward over the limestone at Trenton Falls, and thence southeastward to its present mouth at Herkimer. The gorge, between Prospect and Trenton Falls villages, is 2½ miles long and from 100 to 200 feet deep, and has been cut into the Trenton limestone by the postglacial stream. It contains five or six waterfalls ranging in height from 10 to 126 feet, the total drop of the water in the 2½ miles of the gorge being 360 feet (see plates 43 and 44).

In the southeastern Adirondacks, the upper waters of the Hudson river present some very interesting examples of drainage changes. In fact, it is not too much to say that the larger drainage features of that region have been well nigh revolutionized as a result of glaciation. The accompanying sketch map (fig. 37) gives a fair idea of the changes, but reference to the State geologic map and to the topographic maps of the region is greatly to be desired. The State geologic map shows two distinct embayments of Paleozoic rocks forming valleys which extend northward, one to Northville and the other to Corinth, and into the mass of Precambric rocks of the

Adirondacks. It is certain that these valleys contained important preglacial streams which flowed southward out of the mountains. Now, however, the Sacandaga river enters the north end of the

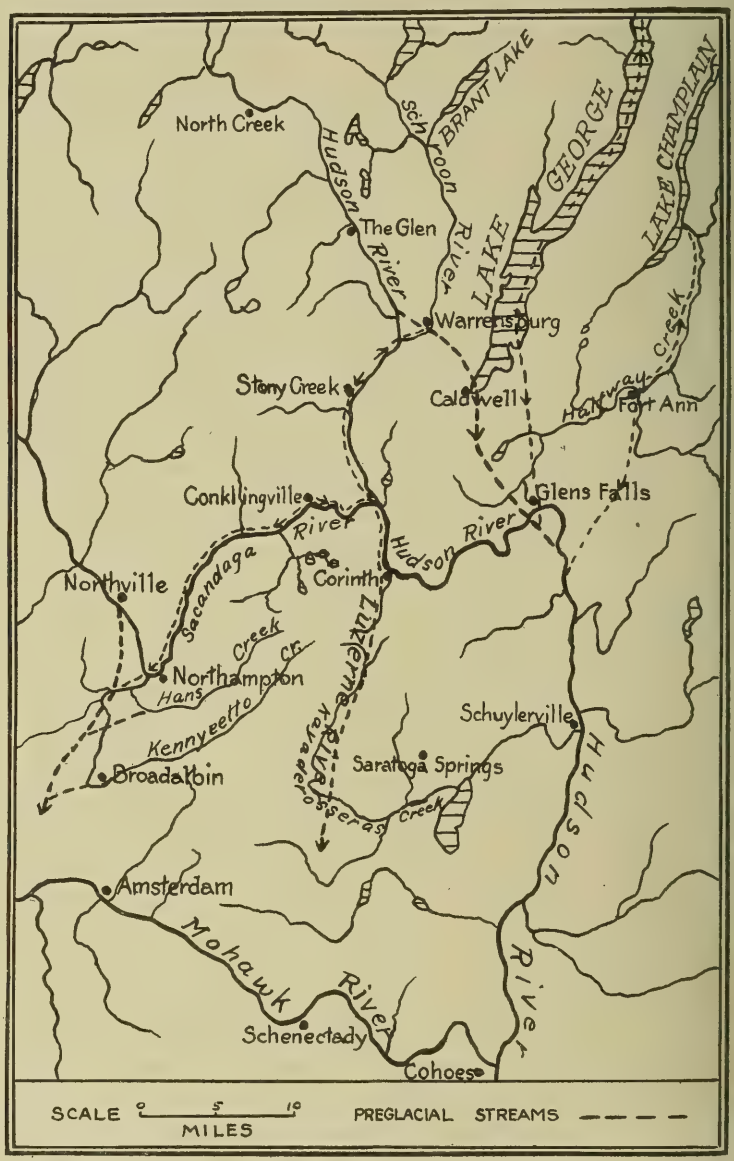


FIG. 37 Sketch map of the southeastern Adirondack region, showing the relation of the preglacial drainage to that of the present. Preglacial courses shown only where essentially different from present streams.

After W. J. Miller, Bul. Geol. Soc. Am., vol. 22

High Falls in the gorge at Trenton Falls, Oneida county. Both the upper and lower portions of the falls are shown, the total descent of the water being 126 feet. The rock is Trenton limestone, at its classic locality, and it abounds in early Paleozoic fossil shells. The gorge here is 200 feet deep and wholly of postglacial origin.

Photo by F. B. Guth, Utica, N. Y.

A nearer view of the upper portion of the High Falls, at Trenton Falls, Oneida county. The height of this fall is 50 feet.

Photo by F. B. Guth, Utica, N. Y

first named valley only to make a very sharp turn back on its course to flow across the mountains and into the Hudson at Luzerne. A preglacial divide was located at Conklingville as shown by the gorge there; the perfectly graded condition of the valley bottom westward from that place; and the flaring of the valley westward. This remarkable deflection of the river was caused by the building of a morainic blockade across the southern end of the Paleozoic rock valley from Broadalbin to Gloversville. The peculiar courses of Hans and Kennyetto creeks are thus also easily explained.

The Hudson river now flows through a gorge more than 1000 feet deep just above Stony Creek station, and thence to the north end of the Paleozoic rock valley at Corinth where it turns abruptly to the northeast to flow across the Luzerne mountain ridge. The preglacial Hudson certainly did not flow through the Stony creek gorge, but rather, where the gorge now is, there was an important divide. Among other proofs for this former divide are: the deep, narrow gorge of recent origin; the flaring of the valley both northward and southward from the gorge; and the anomalous turns of both the Hudson and Schroon rivers toward the southwest through a highland region of hard rock, instead of southeastward across the much lower land between Warrensburg and Lake George. The most probable preglacial channel was past Warrensburg, Caldwell, and Glens Falls as shown on the map. The now extinct Luzerne river started on the Stony creek divide, and flowed southward past Corinth and thence through the Paleozoic rock valley to the west of Saratoga Springs. The cause of the passage of the Hudson over the Stony creek divide was partly due to a lowering of the divide by ice erosion, but mostly to the fact that during the ice retreat the ice lobe in the Lake George depression forced the Hudson river to take a more westerly course which was continued after the melting of the ice. The deflection of the river across the Luzerne mountain divide was certainly caused by heavy drift accumulations in the Paleozoic rock valley south of Corinth.

The famous Ausable chasm in Clinton county is a fine illustration of a deep, narrow gorge cut through the Potsdam sandstone by the Ausable river since the Ice age. The river was deflected from its preglacial channel by heavy drift filling.

According to evidence recently presented by Fairchild, the lower portion of the Black river did not flow, as now, westward past Watertown and into the Ontario basin, but continued northward to northeastward into the St Lawrence valley and in perfect

harmony with the rock structures and other drainage lines. The diversion from the preglacial course was due to heavy glacial accumulations between the villages of Black River and Evans Mills.

The deep, narrow gorges which have been cut through the steep eastern and northeastern fronts of the Tug Hill plateau are commonly called "gulfs." Of these the Whetstone gulf (see plate 8) is the most interesting and though little known it is one of the finest examples of its kind in the State. Its length is two miles, and for one mile it shows a depth of 300 feet. The walls are very steep-sided to nearly vertical, especially in the upper end (narrows) where there is just room enough for the swift stream at the bottom. This gulf is certainly postglacial in origin and has been cut into the soft Lorraine and Utica shales. During glacial times the shales were eroded back by the ice (see above) causing the development of the steep eastern front of Tug hill. After the ice disappeared, all east-bound streams from Tug hill, not in their preglacial channels, rushed over the steep shale front and began to erode notches into its summit. These notches were rapidly deepened in the soft shales to form the gulfs whose heads have since been cut back to their present positions.

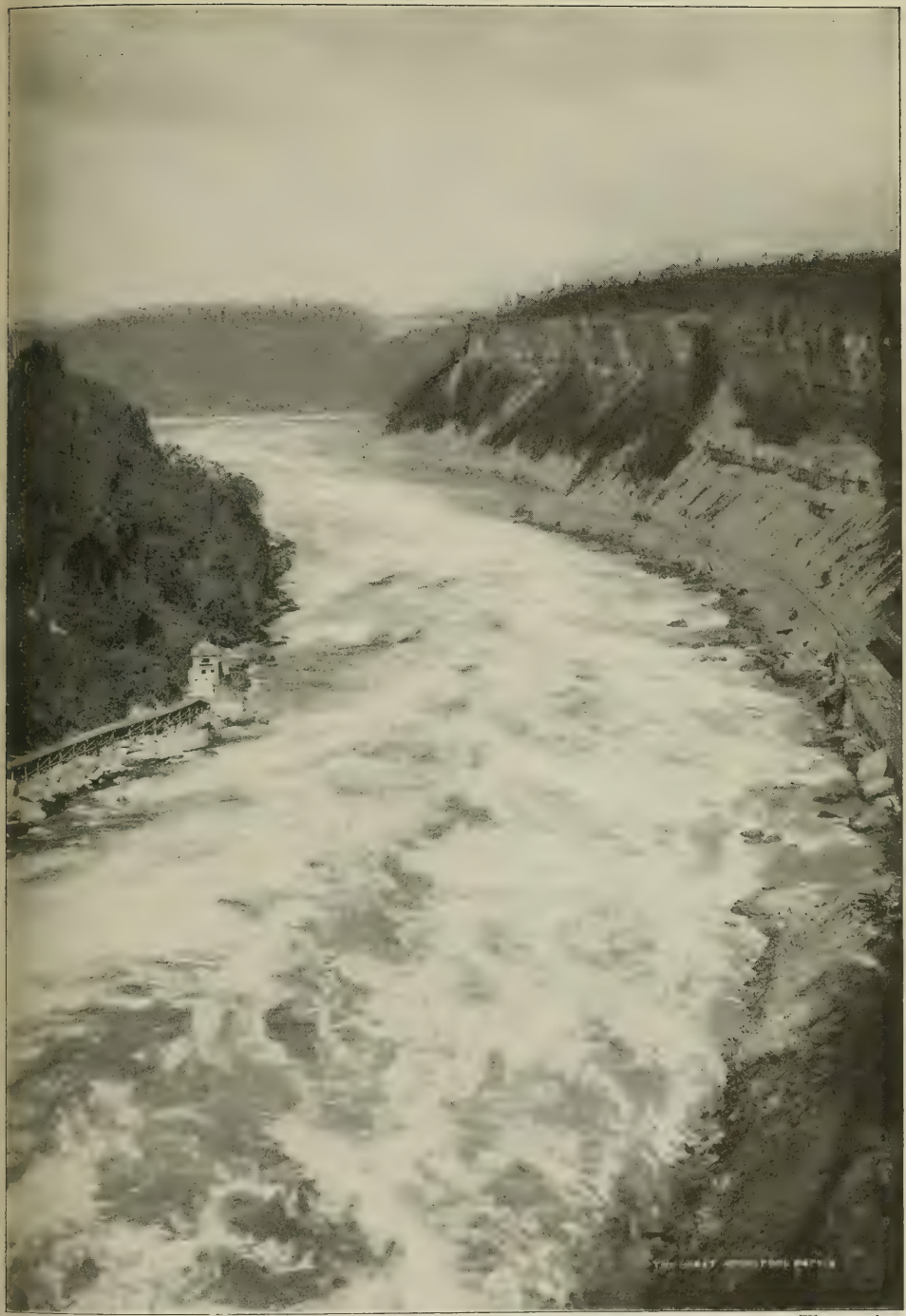
The world famous Niagara Falls and gorge are wholly postglacial in origin. After plunging 167 feet at the falls, the river rushes for 7 miles through the gorge whose depth is between 200 and 300 feet (plates 47, 48, 49 and 50). When the glacial waters in the eastern Great Lakes region had dropped to the Iroquois level, the Niagara limestone terrace in the vicinity of Buffalo and with steep escarpment or northern front at Lewiston and Queenston, ceased to be covered by lake water, and the Niagara river came into existence by flowing northward over this limestone plain. The river first plunged over the escarpment at Lewiston and Queenston, thus inaugurating Niagara Falls there. Since that time the falls have receded the 7 miles up stream to their present position. In figure 38 we see that soft shales underlie the hard layer of Niagara limestone, and the recession of the falls has clearly been caused by the breaking off of blocks of limestone due to undermining of the soft shales. A glance at the map (plate 50) will show that the gorge development is really taking place on the Horseshoe falls side where the volume of water is much greater, and that in a short time, geologically considered, the American falls will be dry. The rocks exposed in the gorge walls are Niagara limestone, under which in regular order come Niagara (Rochester) shale, Clinton

General view of Niagara Falls from the American side

From N. Y. State Mus. Bul. 45 pl. 1

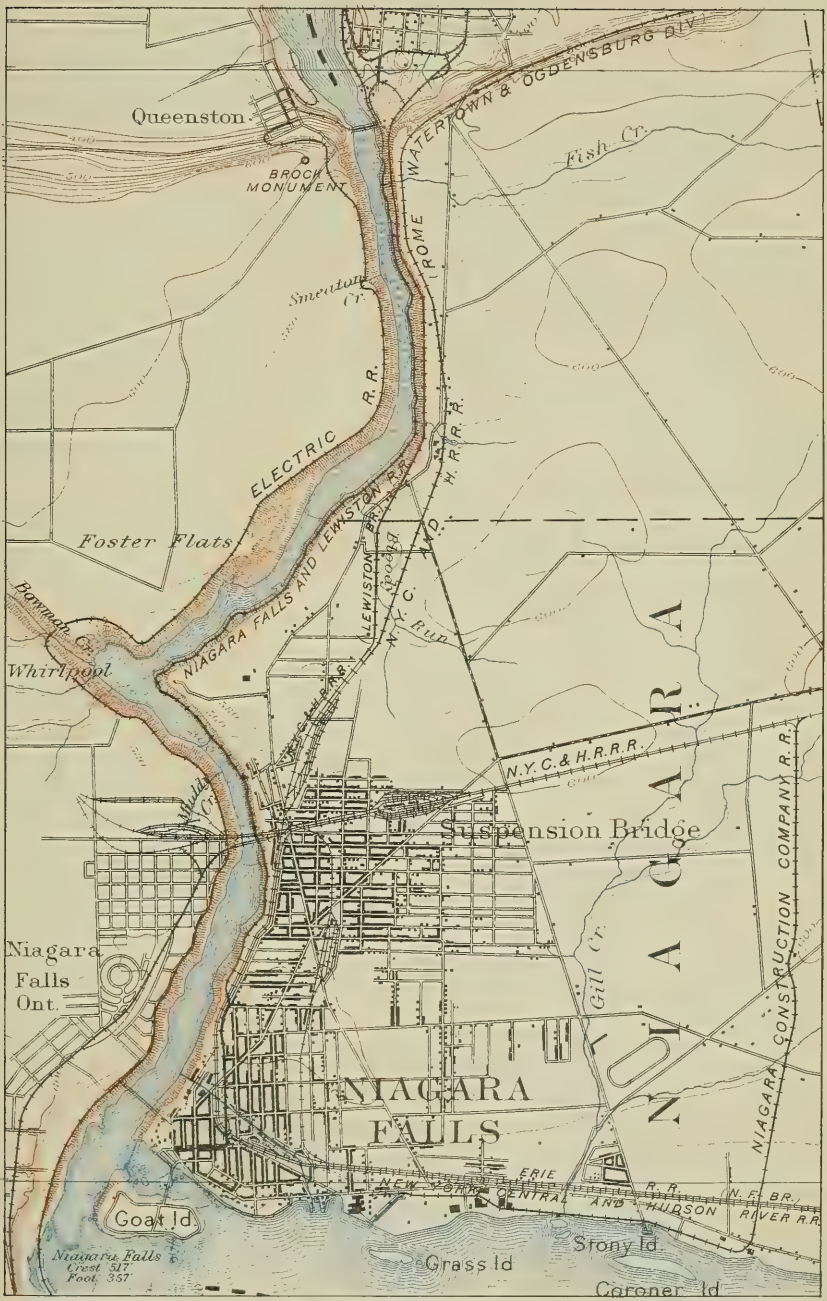
The Horseshoe falls with Goat island and the Three Sisters, as seen from the Canadian side. This view illustrates the narrowness of the gorge now forming.

From N. Y. State Mus. Bul. 45, pl. 11



The Whirlpool rapids and American bank of Niagara gorge, looking north. The rocks are nearly horizontal strata of Siluric age consisting of Lockport or Niagara limestone (forming uppermost cliff) followed downward by Rochester shale, Clinton limestone and shale (exposed near middle of bank), and Medina sandstone and shale. The gorge is here 250 feet deep.

From N. Y. State Mus. Bul. 45, pl. 10



Portion of the Niagara Falls (U. S. G. S.) quadrangle, showing the position of the Falls, the long, narrow gorge cut through the very level Ontario plain, the position of the Whirlpool and the "Niagara escarpment" at Queenston. Scale, about 1 mile to the inch.

shale, and Medina shale and sandstone. These formations show only a slight southward dip or tilt.

The Genesee river from its source to Portageville, Wyoming county, appears to be in a mature preglacial valley. Near Portageville, however, the river plunges into a deep, narrow, rock gorge of postglacial origin, which continues for 25 miles to Mount Morris. This gorge has been cut through soft Devonic shales and shaly sandstones, and its walls are mostly nearly vertical, often rising to heights of several hundred feet. The three noted Portage falls (see plate 51) are situated just below Portageville, the upper falls

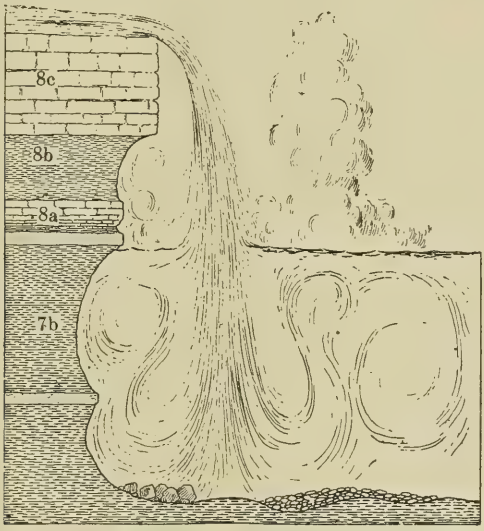


FIG. 38 Section at Niagara Falls, showing the character and position of the rock formations and the depth of water below the falls.
After Gilbert

plunging 66 feet, the middle falls 110 feet, and the lower falls 96 feet. According to Grabau, the preglacial course between Portageville and Mount Morris was farther westward along the present Oatka creek. A second postglacial gorge is entered at Rochester, and this continues for 7 miles to the mouth of the river. Here, also, are three falls, the first over Niagara limestone being 98 feet, the second over Clinton shale and limestone being 20 feet, and the third over Medina sandstone being 105 feet. The preglacial channel here was probably a little to the east and through Irondequoit bay.

In the southern Finger lakes region of south-central New York there are numerous postglacial gorges, a few of the best known ones being: Watkins and Havana glens near the southern end of Seneca lake, Taughannock gorge on the west side of Cayuga lake and in northern Tompkins county, and the gorges of Butternut (Enfield), Fall, Six Mile, and Buttermilk creeks in the vicinity of Ithaca. These gorges all contain waterfalls and have been cut into Devonic shales or sandy shales by streams which have been either partly or wholly diverted from their preglacial courses due to heavy drift filling. In some cases, as at Watkins and Taughannock, the main north-south Seneca and Cayuga valleys were scoured and somewhat deepened by ice erosion, while in all cases the tributary channels were heavily drift filled, thus accounting for the frequent postglacial diversion of these streams which were forced to cut new channels into the steep slopes facing the main valleys.

Watkins glen is several miles long, often very narrow, and with a maximum depth of over 300 feet. Taughannock gorge, which is one and a quarter miles long and with greatest depth of about 350 feet, has in it Taughannock falls whose height is 215 feet and which takes rank as the highest true waterfall in New York State (see frontispiece). Fall creek gorge, on the north side of Cornell campus, is about a mile long and with greatest depth of about 200 feet, and contains Triphammer and Ithaca falls. The Butternut creek (Enfield) gorge is two miles long and with maximum depth of over 300 feet.

In Chautauqua county there are numerous gorges or so-called gulfs which have been cut through the steep front or escarpment of the western border of the Southwestern plateau province. A fine example is the gulf south of Westfield, which is several miles long and from 300 to 400 feet deep. These are also postglacial channels which have been worn into the soft Devonic shales. The steepness of the shale escarpment here, as in the case of Tug hill, was more than likely produced by ice erosion, while the preglacial north-flowing streams had their channels partially or completely filled with glacial debris so that the streams now often flow in postglacial channels. The conditions are here very similar to those of the Finger lakes region already described.

Length of time since the Ice age. Estimates of the duration of the glacial epoch by the most able students of the subject vary from 500,000 to 1,500,000 years, these estimates being based on such criteria as amount of erosion and weathering of the earliest till sheets (in Mississippi valley), times necessary for the various

Middle falls and the gorge of the Genesee river just below Portageville. The falls are 110 feet high and the exposed rocks are shales and sandstones of Portage (Devonic) age. The gorge is postglacial in origin.

From N. Y. State Mus. Bul. 118, pl. 15

Plate 52

Triphammer falls and gorge at the edge of Cornell University campus, Ithaca, N. Y. The rocks are dark, thin bedded shales of Lower Portage (Devonic) age. The gorge is postglacial in origin.

From N. Y. State Mus. Bul. 19, pl. 81

advances and retreats of the ice sheets etc. Although a closer calculation is well nigh impossible because of the variability of the factors involved from time to time, it is nevertheless certain that, from the geological standpoint, the Ice age was of short duration, while, from the standpoint of known human history, it was immensely long.

Estimates of the length of time since the close of the Ice age are perhaps more satisfactory, though it must be remembered that the close of the Ice age was not at the same time for all places. The ice retreated northward very slowly and when, for example, southern New York was free from the ice, northern New York was still glaciated. The best estimates for the length of time since the

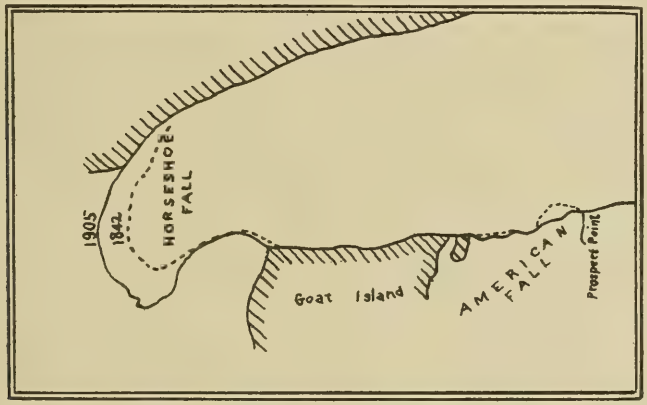


FIG. 39 Sketch map showing the relation of the crest of Niagara Falls in 1842 to that of 1905. Based upon actual surveys. The retreat of the inner portion of the Horseshoe Fall was more than 300 feet.

Modified after Gilbert, U. S. G. S. Bul. 306, p. 20

close of the Ice age in New York State are based upon the rate of recession of Niagara falls. We have learned that the Niagara river began its work about the time the glacial waters in the Erie-Ontario regions had dropped to the Iroquois level, and that the falls were first formed by the plunging of the river over the Niagara limestone escarpment at Queenston and Lewiston. Studies based upon actual surveys, drawings, daguerreotypes, photographs etc. made between the years 1842 and 1905, have shown that the Horseshoe fall had receded about 5 feet a year, while the American fall between 1827 and 1905, had receded about 3 inches a year. Thus the gorge cutting is clearly taking place on the Canadian side. The

length of the gorge is 7 miles, and if we consider the rate of recession to have been always 5 feet a year, the length of time necessary to cut Niagara gorge would be something over 7000 years. But the problem is not so simple, since we know that at the time of, or shortly after, the beginning of the river, the upper lakes drained out through the Trent river, and then still later through the Ottawa river. So it is evident that, for a good part of the time since the ice retreated from the Niagara region, the volume of water passing over the falls was notably diminished, and hence the length of time for the gorge cutting increased. The best estimates for the length of time since the ice retreated from the Niagara region vary from 7000 to 50,000 years, an average being about 25,000 years. In a similar way the time based upon the recession of St Anthony's falls, Minnesota, range from about 10,000 to 16,000 years. While closer estimates are practically impossible, it is at least certain that the time since the Ice age is far less than its duration, and that, for the region of New York State, the final ice retreat occurred only a very short time ago.

When we consider the slight amount of weathering and erosion of the latest glacial drift, we are also forced to conclude that the time since the close of the Ice age in New York is to be measured only by some thousands of years. Thus kames, drumlins, extinct lake deltas, and moraines with their kettle holes have generally been very little affected by ice erosion since their formation.

Champlain subsidence and recent elevation of New York State. We have already shown that at about the beginning of the glacial epoch the region of New York State, especially along the eastern side, was much higher than it is today, positive proof for this being afforded by the submerged Hudson river channel which must have been cut when the land was higher. Toward the close of the Ice age and shortly after (Champlain epoch), we know that the land had subsided to a level even lower than that of today. It was during this period of subsidence that the lower Hudson and St Lawrence channels were submerged and the sea coast was transferred to more nearly its present position. But as the land was even lower than now, the lowlands of Long island and in the vicinity of New York City were under water and a narrow arm of the sea extended through the Hudson and Champlain valleys to join a broad arm of the sea which reached up the St Lawrence valley and even into the Ontario basin (see figure 34). This Champlain sea existed at the time of the Nipissing Great Lakes already described. Champlain sea beaches, containing marine shells and

the bones of walruses and whales, have been found at altitudes of about 400 feet near the southern end of Lake Champlain, to 500 feet at its northern end, and 600 or more feet at the eastern end of Lake Ontario. In the lower Hudson river valley the deposits of this age are about 70 feet above sea level, and at Albany a little over 300 feet. The altitudes of these so-called raised beaches show how much lower the land was during the time of greatest submergence, and that the subsidence was most toward the north.

The most recent movement of the earth's crust over the area of the State was the very recent gradual elevation which expelled the Champlain sea and left the land at its present altitude. The altitudes of the raised Champlain beaches show that the greatest elevation was on the north. The warping of the Iroquois beaches already described occurred at this same time. Actual surveys during the past century have proved that the upward movement in the northern Great Lakes region is still progressing at the rate of 5 inches in 100 miles in 100 years.

APPENDIX

CONSTRUCTION AND USES OF GOVERNMENT CONTOUR MAPS

A number of plates, comprising portions of government topographic (contour) maps, have been introduced into this book for the purpose of illustrating the typical relief features of various parts of the State. Since many persons are not familiar with these maps and their uses, a brief explanation is here given.

These topographic maps, which are called sheets or quadrangles, are rectangular in shape and bounded by latitude and longitude lines. The size of each map is about 17½ inches high by 11½ to 16 inches wide, the latter varying with the latitude. In New York State the scale is nearly always 1 to 62,500 or nearly one mile to the inch, such a sheet or quadrangle covering an area of just one-sixteenth of a square degree. The most valuable feature of these maps is the fact that the surface configuration (relief) of the country is so accurately shown, this feature being explained by the accompanying figures and the following description which is generally found printed on the back of each map: "Relief is shown by contour lines in brown. Each contour passes through points which have the same altitude. One who follows a contour on the ground will go neither up hill nor down hill, but on a level. By the use of the contours not only are the shapes of the plains, hills, and mountains shown, but also the elevations. The line of the sea coast itself is a contour line, the datum or zero of elevation being the mean sea level. The contour line at, say, 20 feet above sea level is the line that would be the sea coast if the sea were to rise or the land to sink 20 feet. Such a line runs back into the valleys and forward around the points of hills and spurs. On a gentle slope this contour line is far from the present coast line, while on a steep slope it is near it. Thus a succession of these contour lines far apart on the map indicates a gentle slope; if close together, a steep slope; and if the contours run together in one line, as if each were vertically under the one above it, they indicate a cliff. . . . The contour interval, or vertical distance in feet between one contour and the next, is stated at the bottom of each map. This interval varies according to the character of the area mapped; in a flat country it may be as small as 5 feet; in a mountainous region it may be 200 feet. Certain contours, usually every fifth one, are

accompanied by figures stating elevation above sea level. The heights of many definite points, such as road corners, railroad stations, railroad crossings, summits, water surfaces, triangulation stations, and bench marks, are also given. The figures in each case are placed close to the point to which they apply, and express the elevation to the nearest foot only. . . . All water features are shown in blue, the smaller streams and canals in full blue lines, and the larger streams, lakes, and the sea by blue water lining. . . . The works of man are shown in black, in which coloring all letter-

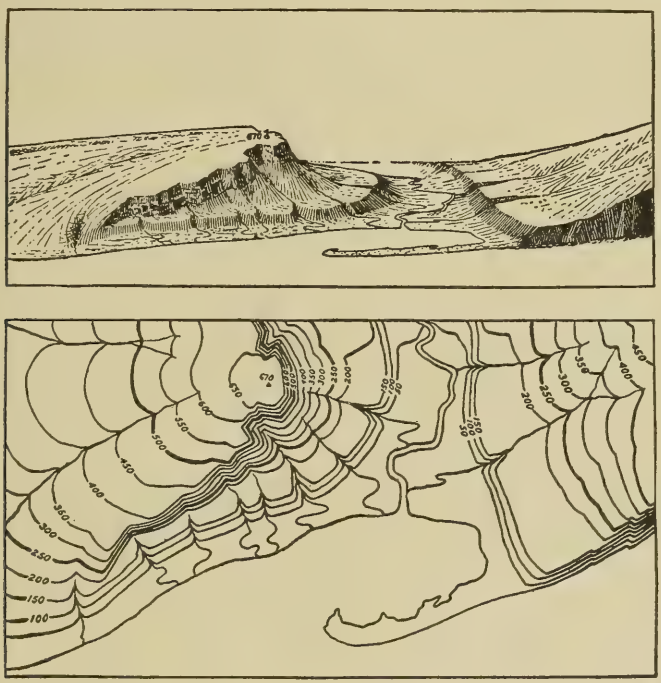


FIG. 40 Ideal sketch and corresponding contour map (U. S. G. S.).

ing also is printed. . . . Houses are shown by small black squares which in the densely built portions of cities and towns merge into blocks. Roads are shown by fine double lines, trails by single dotted lines, and railroads by full black lines with cross lines. Other cultural features are represented by conventions which are easily understood. The sheets composing the topographic atlas are designated by the name of a principal town or of some prominent natural feature within the quadrangle and the names of the adjoining published sheets are printed on the margins. They are sold

at ten cents each when fewer than 50 copies are purchased, but when ordered in lots of 50 or more copies, whether of the same or of different sheets, the price is six cents each."

These maps are published by the United States Geological Survey, and orders for them should be sent to the director of that bureau at Washington, D. C. The order should be accompanied by cash or a post office money order. Each quadrangle has a special name by which it must be ordered. A large portion of New York State has been covered by such topographic surveys and, in order to know how to get the map covering a given region, reference should be made to the Index to Atlas Sheets for New York State. This index may be procured free of charge by dropping a post card to the Director of the United States Geological Survey.

The value of these maps to teachers of geography and physical geography would be difficult to overestimate, and every school should have a supply of these maps readily accessible. For the teaching of home geography as well as that of other parts of the State, for example, Niagara Falls, the Thousand Islands, New York City and vicinity, etc., no other map is comparable because, in addition to the ordinary features, the relief (topography) of the land is shown in detail. In other states, also, many places of importance or geographic interest have been covered by such maps.

BIBLIOGRAPHY

This bibliography includes only the bulletins and papers of a more general character dealing with the physical features of New York State. There is no attempt at completeness. An extended list of all State Museum publications is given at the end of this bulletin, but many important, though technical or special, publications of the State Museum are not named in this chapter. The most exhaustive lists of papers dealing with the geology of New York, both those issued by the New York State Museum and published elsewhere, are to be found in United States Geological Survey Bulletins 127, 188, 189, 301, 372, 409, 444 and 495, covering the years 1732 to 1910 inclusive. For still later years other bulletins will appear. By referring to "New York" in the index, the subjects and regions treated may be readily found. Numerous references are also given in Tarr's Physical Geography of New York State. The reader who desires to know what scientific publications of the New York survey refer to a given subject or region should address the Director of the State Museum, Education Building, Albany, N. Y.

New York State Museum Bulletins

19 **Merrill, F. J. H.** Guide to the Study of the Geological Collections of the New York State Museum. 1898

21 **Kemp, J. F.** Geology of the Lake Placid Region. 1898

34 **Cumings, E. R. & Prosser, C. S.** Lower Silurian System of Eastern Montgomery County and Stratigraphy of the Mohawk Valley. 1900

42 **Ruedemann, R.** Hudson River Beds near Albany. 1901

45 **Grabau, A. W.** Geology of Niagara Falls and Vicinity. 1901

48 **Woodworth, J. B.** Pleistocene Geology of Nassau County and Borough of Queens. 1901

63 **Clarke, J. M. & Luther, D. D.** Stratigraphy of Canandaigua and Naples Quadrangles. 1904

77 **Cushing, H. P.** Geology of the Vicinity of Little Falls. 1905

81 **Clarke, J. M. & Luther, D. D.** Watkins and Elmira Quadrangles. 1905

82 **Clarke, J. M.** Geologic Map of the Tully Quadrangle. 1905

83 **Woodworth, J. B.** Pleistocene Geology of the Mooers Quadrangle. 1905

84 —— Ancient Water Levels of the Champlain and Hudson Valleys. 1905

92 **Grabau, A. W.** Geology and Paleontology of the Schoharie Region. 1906

95 **Cushing, H. P.** Geology of the Northern Adirondack Region. 1905

96 **Ogilvie, I. H.** Geology of the Paradox Lake Quadrangle. 1905

99 **Luther, D. D.** Geology of the Buffalo Quadrangle. 1906

101 —— Geology of the Penn Yan-Hammondsport Quadrangles. 1906

106 **Fairchild, H. L.** Glacial Waters in the Erie Basin. 1907

111 —— Drumlins of New York. 1907

114 **Hartnagel, C. A.** Geological Map of the Rochester and Ontario Beach Quadrangles. 1907

115 **Cushing, H. P.** Geology of the Long Lake Quadrangle. 1907

118 **Clarke, J. M. & Luther, D. D.** Geologic Maps and Descriptions of the Portage and Nunda Quadrangles including a Map of Letchworth Park. 1908

126 **Miller, W. J.** Geology of the Remsen Quadrangle including Trenton Falls and vicinity. 1909

127 **Fairchild, H. L.** Glacial Waters in Central New York. 1909

128 **Luther, D. D.** Geology of the Geneva-Ovid Quadrangles. 1909

135 **Miller, W. J.** Geology of the Port Leyden Quadrangle. 1910

137 **Luther, D. D.** Geology of the Auburn-Genoa Quadrangles 1910

138 **Kemp, J. F. & Ruedemann, R.** Geology of the Elizabethtown and Port Henry Quadrangles. 1910

145 **Cushing, H. P.; Fairchild, H. L.; Ruedemann, R., & Smyth, C. H.** Geology of the Thousand Islands Region. 1910

146 **Berkey, C. P.** Geologic Features and Problems of the New York City Aqueduct. 1911

148 **Gordon, C. E.** Geology of the Poughkeepsie Quadrangle 1911

152 **Luther, D. D.** Geology of the Honeoye-Wayland Quadrangles. 1911

153 **Miller, W. J.** Geology of the Broadalbin Quadrangle. 1911

154 **Stoller, J. H.** Glacial Geology of the Schenectady Quadrangle. 1911

160 **Fairchild, H. L.** Glacial Waters in the Black and Mohawk Valleys. 1912

169 **Cushing, H. P. & Ruedemann, R.** Geology of Saratoga Springs and Vicinity.

Hopkins, T. C. Geology of the Syracuse Quadrangle.

Miller, W. J. Geology of the North Creek Quadrangle.

Natural History Survey of New York. Division 4 (Geology). 1842-43

For this survey the State was divided into four districts and the reports cover all the counties of the State.

V. 1 pt 1 **Mather, W. W.** First Geological District. 1843

V. 2 pt 2 **Emmons, E.** Second Geological District. 1842

V. 3 pt 3 **Vanuxem, L.** Third Geological District. 1842

V. 4 pt 4 **Hall, J.** Fourth Geological District. 1843

New York State Museum handbooks

No. 15 **Clarke, J. M.** Guide to Excursions in the Fossiliferous Rocks of New York. 1899

No. 19 **Hartnagel, C. A.** Classification of the Geologic formations of the State of New York. 1912

New York State Museum State maps

Economic and Geologic Map of the State of New York. Scale 14 miles to 1 inch. 1894

Geologic Map of New York. Scale 5 miles to 1 inch. 1901

Map of New York Showing the Surface Configuration and Water Sheds. 1901

United States Geological Survey folios

No. 83 New York City and Vicinity. By Merrill, Darton, Hollick, Willis, Salisbury, Dodge, & Pressey.

No. 169 Watkins Glen-Catatonk. By Williams, Tarr & Kindle.

Miscellaneous papers

Baldwin, S. P. Pleistocene History of the Champlain Valley. Amer. Geologist, 13: 170-84. 1894

Bishop, I. P. Structural and Economic Geology of Erie County. Fifteenth Ann. Rep't N. Y. State Geol., p. 305-92. 1897

Brigham, A. P. The Geology of Oneida County. Oneida Nat. Hist. Soc. Trans. for 1888, p. 102-18

—— The Finger Lakes of New York. Amer. Geo. Soc. Bul. 25, p. 203-23. 1893

—— Glacial Flood Deposits in the Chenango Valley. Geol. Soc. Amer. Bul. 8, p. 17-30. 1897

—— Topography and Glacial Deposits of the Mohawk Valley. Geol. Soc. Amer. Bul. 9, p. 183-210. 1898

—— Glacial Geology of the Broadalbin, Gloversville, Amsterdam and Fonda Quadrangles. N. Y. State Mus. Bul. 121, p. 21-31. 1908

Berkey, C. P. Structural and Stratigraphic Features of the Basal Gneisses of the Highlands. N. Y. State Mus. Bul. 107, p. 361-78. 1906

—— Areal and Structural Geology of Southern Manhattan Island. N. Y. Acad. Sci., 19: 247-82. 1909

Clarke, J. M. Brief Outline of the Geological Succession in Ontario County. N. Y. State Geol. Rep't 4, p. 9-22. 1885

Clarke, J. M. Report of Fieldwork in Chenango County. 47th Ann. Rep't N. Y. State Mus., p. 725-51. 1894

Cushing, H. P. Report on the Geology of Clinton County. N. Y. State Geol. Rep't 13, p. 473-89. 1894

—— Report on the Geology of Clinton County. N. Y. State Geol. Rep't 15, p. 499-573. 1895

—— Report on the Geology of Franklin County. N. Y. State Geol. Rep't 18, p. 73-128. 1899

—— Geology of Rand Hill and Vicinity, Clinton County. N. Y. State Geol. Rep't 19, p. 37-82. 1901

—— Geologic Work in Franklin and St Lawrence Counties. N. Y. State Geol. Rep't 20, p. 23-95. 1902

Darton, N. H. Report on the Geology of Albany County. N. Y. State Geol. Rep't 13, p. 229-61. 1894

—— Report on the Geology of Ulster County. N. Y. State Geol. Rep't 13, p. 289-372. 1894

—— Geology of the Mohawk Valley in Herkimer, Fulton, Montgomery and Saratoga Counties. N. Y. State Geol. Rep't 13, p. 407-29. 1894

—— Shawangunk Mountain. Nat. Geog. Mag. 6: 23-34. 1894

—— Description of the Faulted Region of Herkimer, Fulton, Montgomery and Saratoga Counties. N. Y. State Geol. Rep't 14, p. 31-53. 1895

Fairchild, H. L. Pleistocene Geology of Western New York. N. Y. State Geol. Rep't 20, p. 1103-39. 1902

—— Latest and Lowest Pre-Iroquois Channels between Syracuse and Rome. N. Y. State Geol. Rep't 21. 1903

—— Glacial Waters from Oneida to Little Falls. N. Y. State Geol. Rep't 22, p. 117-41. 1904

Gilbert, G. K. Niagara Falls and their History. Nat. Geog. Monograph v. 1, no. 7, p. 203-36. 1895

—— Rate of Recession of Niagara Falls. U. S. G. S. Bul. 306. 1907

Grabau, A. W. The Preglacial Channel of the Genesee River. Boston Soc. Nat. Hist. Proc., 26: 359-69. 1894

Gratacap, L. P. Geology of the City of New York. Third ed. Henry Holt Co. 1909

Hall, J. & Clarke, J. M. Stratigraphic and Faunal Relations of the Oneonta Sandstones, the Ithaca and the Portage Groups in Central New York. With Maps. N. Y. State Geol. Rep't 15, p. 27-81. 1897

Hartnagel, C. A. Formations of the Skunnemunk Mountain Region. N. Y. State Mus. Bul. 107, p. 39-54. 1906

Heilprin, A. The Catskill Mountains. Amer. Geog. Soc. Bul. 39, no. 4, p. 193-99. 1907

Hobbs, W. H. Origin of the Channels Surrounding Manhattan Island. Geol. Soc. Amer. Bul. 16, p. 151-82. 1905

Kemp, J. F. Report on the Geology of Essex County. N. Y. State Geol. Rep't 13, p. 431-72. 1894; and N. Y. State Geol. Rep't 15, p. 575-614. 1897

—— Physiography of the Eastern Adirondack Region in the Cambrian and Ordovician Periods. Geol. Soc. Amer. Bul. 8, p. 408-12. 1897

—— **& Newland, D. H.** Report on the Geology of Washington, Warren and Parts of Essex and Hamilton Counties. N. Y. State Geol. Rep't 17, p. 499-553. 1899

—— **Newland, D. H. & Hill, B. F.** Report on the Geology of Hamilton, Warren, and Washington Counties. N. Y. State Geol. Rep't 18, p. 137-62. 1899

—— **& Hill, B. F.** Report on the Precambrian Formations in Parts of Warren, Saratoga, Fulton and Montgomery Counties. N. Y. State Geol. Rep't 19, p. 117-35. 1901

—— Physiography of the Adirondacks. Popular Sci. Monthly, 68: 195-210. March 1906

Kümmel, H. B. The Newark or New Red Sandstone Rocks of Rockland County. N. Y. State Geol. Rep't 18, p. 9-50. 1899

Lincoln, D. F. Structural and Economic Geology of Seneca County. N. Y. State Geol. Rep't 14, p. 57-125. 1895

Luther, D. D. Economic Geology of Onondaga County. N. Y. State Geol. Rep't 15, p. 237-303. 1897

—— Brine Springs and Salt Wells of New York, and the Geology of the Salt District. N. Y. State Geol. Rep't 16, p. 171-226. 1899

Merrill, F. J. H. Quaternary Geology of the Hudson River Valley. N. Y. State Geol. Rep't 10, p. 103-55. 1891

Miller, W. J. Ice Movement and Erosion along the Southwestern Adirondacks. Amer. Jour. Sci., 4th ser., 27: 289-98. 1909

—— Exfoliation Domes in Warren County. N. Y. State Mus. Bul. 149, p. 187-94. 1911.

—— Preglacial Course of the Upper Hudson River. Geol. Soc. Amer. Bul. 22, p. 177-86. 1911

—— Early Paleozoic Physiography of the Southern Adirondacks. To appear in the 9th annual report of the Director of Science Division for 1912

Prosser, C. S. Hamilton and Chemung Series of Central and Eastern New York. Pt 1, N. Y. State Geol. Rep't 15, p. 83-222, 1897; pt 22, N. Y. State Geol. Rep't 17, p. 65-315. 1899

—— **& Cumings, E. R.** Lower Silurian (Ordovician) Formations on West Canada Creek and in the Mohawk Valley. N. Y. State Geol. Rep't 15, p. 615-59. 1897

—— **& Rowe, R. B.** Geology of the Eastern Helderbergs. N. Y. State Geol. Rep't 17, p. 329-54. 1897

Randall, F. A. Report on the Geology of Cattaraugus and Chautauqua Counties. N. Y. State Geol. Rep't 13, p. 517-27. 1894

Ries, H. Geology of Orange County. N. Y. State Geol. Rep't 15, p. 393-475. 1897

Smyth, C. H. General and Economic Geology of Four Townships in St Lawrence and Jefferson Counties. N. Y. State Geol. Rep't 13, p. 491-515. 1894

—— Report on the Crystalline Rocks of St Lawrence County. N. Y. State Geol. Rep't 15, p. 477-97. 1897

—— Report on Crystalline Rocks of the Western Adirondack Region. N. Y. State Geol. Rep't 17, p. 469-97. 1899.

—— Geology of the Crystalline Rocks in the Vicinity of the St Lawrence River. N. Y. State Geol. Rep't 19, p. 183-104. 1901

Tarr, R. S. Hanging Valleys in the Finger Lakes Region of Central New York. Amer. Geol., 33: 271-91. 1904

Watson, T. L. Some Higher Levels in the Postglacial Development of the Finger Lakes of New York State. N. Y. State Mus. Rep't 51 (1), p. 155-117. 1899

Veatch, A. C. Outlines of the Geology of Long Island. U. S. G. S., Professional Paper 44, p. 53-85. 1906

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New York State Museum

JOHN M. CLARKE, Director

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1 Zoology
2 Botany
3 Economic Geology
4 Mineralogy
5 Entomology
6 "
7 Economic Geology
8 Botany
9 Zoology
10 Economic Geology
11 "
12 "
13 Entomology
14 Geology
15 Economic Geology
16 Archeology
17 Economic Geology
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77	57, v. 1, pt 1						

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—— Dictyonine Hexactinellid Sponges from the Upper Devonic of New York.
—— The Water Biscuit of Squaw Island, Canandaigua Lake, N. Y.
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